

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

9
0691Rp



FORTY-FIRST ANNUAL REPORT OF FORAGE RESEARCH IN NORTHEASTERN UNITED STATES

1977

FOR OFFICIAL USE ONLY

FORTY-FIRST ANNUAL REPORT OF FORAGE RESEARCH
IN NORTHEASTERN UNITED STATES
1977

A Joint Contribution of the
U.S. REGIONAL PASTURE RESEARCH LABORATORY
and
BELTSVILLE AGRICULTURAL RESEARCH CENTER
and
AGRICULTURAL EXPERIMENT STATIONS
OF THE 12 NORTHEASTERN STATES

PARTICIPATING AGENCIES

BELTSVILLE AGRICULTURAL RESEARCH CENTER,
CHESAPEAKE-POTOMAC AREA, and
NORTH ATLANTIC AREA

of the

Northeastern Region
Federal Research
Science and Education Administration
U.S. Department of Agriculture

and

AGRICULTURAL EXPERIMENT STATIONS
of

Connecticut
Delaware
Maine
Maryland
Massachusetts

New Hampshire
New Jersey
New York (Ithaca)
New York (Geneva)

Pennsylvania
Rhode Island
Vermont
West Virginia

This annual report of forage research in the 12 Northeastern States is a progress report and as such may contain statements which may not be verified by subsequent research. The fact that any statement has been made herein does not constitute publication. Citation to particular statements should not be made in publications unless permission has been granted by the contributor.

This report is prepared for the official use of forage crop research workers in the region. Copies are sent to all organizations involved in the forage research program of the 12 Northeastern States, to all investigators in the Northeastern Region, and to some interested institutions outside the region. As it is reproduced in limited numbers, it is not available for general distribution to individuals outside the region. Requests by institutions desiring to be placed on the mailing list or by individuals requesting a particular copy should be addressed to the Director, U.S. Regional Pasture Research Laboratory, University Park, Pa., 16802.

Mention of a trademark name, proprietary product, or specific equipment does not constitute guarantee or warranty or imply approval over or to the exclusion of other comparable products or equipment by the U.S. Department of Agriculture, Agricultural Experiment Stations, or other reporting organizations.

TABLE OF CONTENTS

<u>Page</u>	
iii ...	TABLE OF CONTENTS
ix ...	PREFACE
x ...	AUTHOR INDEX
xiii ...	ROSTER OF RESEARCH AND EXTENSION WORKERS IN NORTHEASTERN UNITED STATES WITH FORAGE CROPS AND GRASSLANDS ORIENTATION
SECTION I - BREEDING, GENETICS, AND PLANT INTRODUCTION RESEARCH	
1	Breeding Alfalfa for Tolerance to Aluminum Toxicity in Acid Soils (J. H. Elgin, Jr., J. E. McMurtrey III, and C. D. Foy)
1	Scientific Names for Crop Plants (E. E. Terrell)
1	Lime Responses of Kentucky Bluegrass and Tall Fescue Cultivars on an Acid, Aluminum-Toxic Soil (J. J. Murray and C. D. Foy)
2	Taxonomy of Grasses of Tribe Triticeae (E. E. Terrell)
2	Forage Grass Breeding, Genetics, and Cytology (J. B. Powell)
2	Breeding Alfalfa for Disease and Insect Resistance (J. H. Elgin, Jr., J. E. McMurtrey III, S. A. Ostazeski, R. H. Ratcliffe, and T. C. Elden)
3	Breeding Tall Fescue for Tolerance to Acid-Soil Conditions (J. J. Murray, J. B. Powell, and C. D. Foy)
3	Breeding of Perennial Forage Grasses (J. S. Shenk, R. W. Cleveland, and M. L. Risius)
4	Breeding Crownvetch for Forage and Slope-Stabilization Usage (M. L. Risius, J. S. Shenk, and R. W. Cleveland)
4	Breeding Cool-Season Forage Species for Improved Feeding Value and Productivity (R. W. Cleveland, M. L. Risius, and J. S. Shenk)
5	Breeding Red Clover and Alfalfa (R. W. Cleveland, M. L. Risius, and J. S. Shenk)
5	Breeding and Genetics of <u>Bromus inermis</u> (G. M. Dunn and H. Z. Lea)
6	Feasibility of Perennial Ryegrass and Hybrid Derivatives as Northern Forage Crops (G. M. Wood, W. M. Sullivan, and J. G. Welch)
6	Physiological Control of Apomixis in Forage Grasses (R. T. Sherwood and B. A. Young)
7	Genetic Variation of Nonstructural Carbohydrate Concentration in Tall Fescue (John A. Balasko)
7	Forage Crop Introductions (D. D. Dolan and W. R. Sherring)
10	Genetic Variability for Reaction to <u>Agromyza frontella</u> (Rondani) in <u>Medicago sativa</u> L. (R. R. Hill, Jr., and R. A. Byers)
11	Selection for Resistance to <u>Leptosphaerulina briosiana</u> in Alfalfa (R. R. Hill, Jr., and K. T. Leath)

SECTION II - ENTOMOLOGY RESEARCH

- 13 Economic Injury Level for Alfalfa Blotch Leafminer (R. A. Byers and Karl Valley)
- 13 Flea Beetle Control on Sod-Seeded Kale and Turnips (H. E. Reed and R. A. Byers)
- 14 Life Table for the Alfalfa Blotch Leafminer (J. A. Plummer and R. A. Byers)
- 14 Host Preference of Sitona Larvae among Legumes (R. A. Byers and W. A. Kendall)
- 14 Selection for Hairy Chinch Bug Resistance in Cool-Season Grasses (R. H. Ratcliffe and P. B. Baker)
- 15 An Isolated Strain of Bacillus thuringiensis that Imparts Pathogenicity to Several Mosquito Species and Corn Rootworm (Diabrotica) Species (Robert M. Faust)
- 15 Plasmid DNA of Bacillus thuringiensis var. kurstaki, var. sotto and Bacillus popilliae (Robert M. Faust)
- 16 Selection for Potato Leafhopper Resistance in Alfalfa (T. C. Elden and R. H. Ratcliffe)
- 16 Catabolic Efficiency of Bacillus popilliae, the Japanese Beetle Pathogen, under Aerobic and Anaerobic Conditions (Robert M. Faust)
- 16 Supplement III to Annual Report of NE-9 for 1977, Entomology Report (B. J. Fiori)
- 18 Control and Bionomical Studies of Livestock and Animal Food Crop Insects in West Virginia (Linda Butler and J. E. Weaver)

SECTION III - PLANT PATHOLOGY RESEARCH

- 19 First Report of Alfalfa Crownwart in the Northeast (K. T. Leath)
- 19 Resistance to Purple Leafspot in Orchardgrass (K. E. Zeiders, C. C. Berg, and R. T. Sherwood)
- 20 Resistance to Brown Leafspot in Smooth Bromegrass (K. E. Zeiders, C. C. Berg, and R. T. Sherwood)
- 20 Diseases of Warm- and Cool-Season Forage Grasses (K. E. Zeiders)
- 21 Papilla Mechanism of Resistance of Grasses to Leafspot Fungi (R. T. Sherwood)
- 21 Methods to Evaluate Responses of Red Clover to Specific Fusaria (K. T. Leath, W. A. Kendall, and R. R. Hill, Jr.)

SECTION IV - GROWTH, PHYSIOLOGY, AND CLIMATIC EFFECTS

- 23 Effects of Genotypes and Environments on Growth and Feeding Quality of Forages (W. A. Kendall)
- 23 Improving Biological Nitrogen Fixation in Forage Legumes and Grasses (L. D. Owens, C. Sloger, and L. D. Kuykendall)
- 23 Alfalfa Physiology and Growth (N. J. Chatterton and G. E. Carlson)
- 24 Dehydrogenase Levels in Cold-Tolerant and Cold-Sensitive Alfalfa (M. Krasnuk, G. A. Jung, and F. H. Witham)

- 25 Magnesium, Ca, and K Concentration in Temperate-Origin Forage Species as Affected by Temperature and Mg Fertilization (C. F. Gross and G. A. Jung)
- 25 Studies on Biochemistry of Plant Pathogenesis (D. L. Gustine)

SECTION V - WEED INVESTIGATIONS

- 27 Use of Herbicides in Forage Crop Management (R. A. Peters and W. M. Dest)
- 27 Annual and Perennial Weed Control in Corn and Forages (N. L. Hartwig)
- 28 Weed Control in Pastures and Forage Crops (D. L. Linscott and R. D. Hagin)
- 29 Herbicide Residues in and on Forages (D. L. Linscott, R. D. Hagin, and R. F. Lucey)

SECTION VI - MANAGEMENT AND PRODUCTION RESEARCH

- 31 Field Evaluation of Some Nitrogen Materials Used for Topdressing Field Corn Grown for Silage (W. W. Washko)
- 31 Establishment (Without Using Herbicides) of Perennial Legumes in a Permanent Grass Sod (D. W. Allinson and R. W. Taylor)
- 32 Minimum Tillage Establishment of Perennial Legumes in Four Grass Swards (D. W. Allinson, R. W. Taylor, and A. Lillquist)
- 33 Handling and Utilizing Animal and Human Wastes in the Soil-Plant System (R. W. Wengel and G. F. Griffin)
- 33 Producing Dried, Immature Forages as Grain Substitutes for Ruminants (R. F. Stafford)
- 34 Influence of Winter Cover Crops, Tillage Practices, and Fertilization on Silage-Corn Yields (Roy L. Flannery)
- 35 Effect of Glyphosate on Minimum-Tillage Establishment of Birdsfoot Trefoil (D. W. Allinson, R. W. Taylor, and A. Lillquist)
- 35 Big Packages as an Alternative Method of Handling Hay (G. D. Wells, J. D. Welch, and J. Beaudry)
- 36 Correlation of Boron Fertilizer Applications with Yield of an Orchardgrass-Ladino Clover Mixture, Boron Soil Test Levels, and Concentration of Forage Produced (Roy L. Flannery)
- 36 Evaluation of Permanent Pastures for Species Composition, Yield, Ground Cover, Grazing Pressure, and other Management Practices (B. S. Baker and R. L. Nestor)
- 36 Establishment and Management of Several Grass and other Species for Forage and Ground Cover (W. C. Stringer)
- 37 Evaluation of Small Grain and Forage Crop Varieties and Production Techniques and Methods for Use in New Jersey (J. R. Justin and J. P. Zublena)
- 37 Adaptability of Forage Legumes (M. A. Sprague)
- 38 Nutrient Utilization Efficiency of Crop Species, Hybrids, and Cultivars (R. H. Fox)
- 39 Production, Mineral Content, IVDMD, and Acceptability to Cattle and Sheep of Some Foreign Varieties of Forage Turnips, Swedes, and Beets (V. Ulrich and G. A. Jung)

- 39 Productivity and Quality of Fertilized Perennial Forages
(L. E. Lanyon)
- 40 Integration and Evaluation of Forage Production, Handling, and
Utilization Systems (D. P. Knievel, E. J. Partenheimer, and
W. L. Kjelgaard)
- 40 Development of Seeding Techniques and Management Systems for
Feed Crops in Southwestern Pennsylvania (W. G. Downs III)
- 41 Effect of Management Factors on Alfalfa Productivity and Persis-
tence (A. A. Hower, Jr., and K. T. Leath)
- 42 Use of Chemical Additives in Forage Preservation (W. L. Kjelgaard,
L. L. Wilson, and H. Nehrir)
- 42 Comparison of Hay Handling Systems (L. L. Wilson, P. C. Lootens,
W. L. Kjelgaard, W. C. Stringer, and D. L. Lee)
- 43 Open and Forested Upland Range for Beef Production (L. L. Wilson,
W. C. Stringer, T. W. Bowersox, and R. H. Fox)
- 43 Pennsylvania's 1977 Alfalfa Production Contest (John E. Baylor)
- 44 Research with Brassica Crops and Fodder Beets in Pennsylvania
(G. A. Jung, R. A. Byers, and C. F. Gross)
- 45 Response of Alfalfa to Irrigation, Fertility, and Cutting Manage-
ment (N. A. Clark and J. H. McNemar)
- 45 Evaluation of Sod-Seeded Pastures Using Dairy Steers and Heifers
(A. M. Decker, J. H. Vandersall, and N. A. Clark)
- 46 Alfalfa Variety Trials (N. A. Clark and J. H. McNemar)
- 46 Sod-Seeding Studies Involving Species, Herbicides, and Seeding
Units (A. M. Decker, R. F. Dudley, and N. A. Clark)
- 46 Improvement of Birdsfoot Trefoil Seed Production Practices
(D. L. Linscott and H. M. Schaaf)
- 47 Pasture Renovation Potential of Glyphosate for Weed Control Prior
to Reseeding Desirable Species (D. L. Linscott)

SECTION VII - ENGINEERING RESEARCH

- 49 Engineering Systems for Forage Crop Production and Use (W. L.
Kjelgaard)
- 50 Processing Dried, Immature Forages as Grain Substitutes for
Ruminants (R. J. Rowe)
- 50 Alfalfa as Human Food (L. F. Whitney)
- 50 Yeast Cultivation on Alfalfa Process Wastes (R. E. Mudgett)
- 51 Solid-State Fermentation Processes in Plant-Protein Recovery
(R. E. Mudgett, R. Rufner, and P. Pellett)
- 51 Enzymatic Methods in Plant-Protein Recovery (R. E. Mudgett and
R. Rufner)

SECTION VIII - NUTRITIVE EVALUATION AND UTILIZATION

- 53 Magnesium Supplementation of Wintering Beef Cows (R. L. Reid,
Susan Morash, and E. K. Inskeep)
- 53 Alternative Management Systems for Tall Fescue and Birdsfoot
Trefoil Using Grazing Ewes and Lambs (R. L. Reid)
- 54 Effects of Magnesium and Sulfur on the Nutritive Quality of
Forages (R. L. Reid and G. A. Jung)

- 55 Development and Application of Laboratory Methods of Evaluating Forage Quality (W. A. Kendall)
- 55 Alfalfa Quality Reduced by Phoma Leafspot (K. T. Leath, W. A. Kendall, and J. S. Shenk)
- 56 Effects on Rumen Fermentation of Magnesium Oxide Supplementation to an All-Corn-Silage Ration (H. Fenner)
- 56 Feeding Dried, Immature Forages as Grain Substitutes for Ruminants (W. P. Apgar)
- 57 Utilization of Digestible Energy in Cattle (H. F. Tyrrell, P. W. Moe, and P. J. Reynolds)
- 57 Energy Value of Feedstuffs on Dairy Cattle (P. W. Moe and H. F. Tyrrell)
- 58 Formaldehyde and Other Additives for Ensiling Forages (D. R. Waldo and H. K. Goering)
- 58 Influence of Heat and Other Processing Variables on the Utilization of Forage Nitrogen (H. K. Goering and D. R. Waldo)
- 59 Growth and Physiological Parameters of Ruminants Grazing on Different Varieties of Fescue Pasture (J. Bond and J. B. Powell)
- 59 Effects of Grinding and Pelleting on the Nutritive Value of Complete Dairy Rations (H. K. Goering and W. E. Wheeler)
- 60 Nutritive Evaluations of Animal Excreta and Cellulosic Crop Residues for Ruminant Feed (L. W. Smith and C. C. Calvert)
- 61 Environmental Microbiological Aspects of Digestion and Use of Cellulosic Crop Residues by Ruminants (M. E. Simpson)
- 61 Intestinal Microorganisms and their Contribution to Animal Health (L. L. Slyter)
- 62 Optimizing Intake and Digestibility of Forages (P. J. Wangsness, B. R. Baumgardt, J. S. Shenk, and W. L. Kjelgaard)
- 62 Breeding Forage Grasses and Evaluation with Infrared Reflectance (J. S. Shenk, M. L. Risius, and R. W. Cleveland)
- 63 Partial Replacement of Concentrate by High-Quality Forage in the Diet of High Producing Cows (E. J. DePeters, E. M. Kesler, and J. M. Buckalew)
- 64 Productivity and Composition of N-Fertilized Grass and Grass-Legume Pastures under Grazing Conditions (L. L. Wilson, P. C. Lootens, D. D. Fisher, and W. C. Stringer)
- 64 Factors Contributing to Hypomagnesemia in Lactating Angus and Angus-Charolais Cows on Pasture (D. D. Fisher, L. L. Wilson, P. C. Lootens, R. W. Scholz, and W. C. Stringer)
- 65 Optimizing Intake and Digestibility of Forages by Ruminants (J. L. Evans, Z. Lelkes, P. Zajac, D. Yoon)
- 65 Optimizing Intake and Digestibility of Forages by Ruminants (J. G. Welch and A. M. Smith)
- 66 Effect of Monensin and Ralgro on Performance of Steer Calves on Pasture (W. E. Kunkle, E. C. Leffel, C. McCullough, R. C. Hammond, and L. W. Douglass)
- 67 Composition and Feeding Value of Broiler Litter (W. E. Kunkle, L. Carr, T. A. Carter, and B. Harmon)
- 67 Supplemental Protein for Gestating Beef Cows Fed Corn Residue (W. E. Kunkle, E. C. Leffel, J. Buric, L. W. Douglass)
- 68 Infrared for the Nutritive Evaluation of Crops and Miscellaneous Feedstuffs (J. S. Shenk, M. R. Hoover, B. R. Baumgardt, W. C. Templeton, Jr., and G. W. Fissel)
- 68 Studies on Allelochemical Properties of Crownvetch and their Effect on Forage Quality (D. L. Gustine, B. G. Moyer, and P. E. Pfeffer)

SECTION IX - SILAGE AND HAY RESEARCH

- 69 Use of Forage Preservatives to Reduce Losses from the Field to the Cow (J. B. Holter)
- 70 Feeding Management Systems to Increase Efficiency of Dairy Production (J. E. Keys and R. E. Pearson)
- 71 Hay Investigations (M. A. Sprague)
- 71 Factors Influencing Safety of Animal Wastes Processed for Livestock Feed (C. C. Calvert)
- 72 The Feeding of Corn Stover Silage to Dry Cows (J. H. Vandersall)
- 72 Alfalfa-Corn Stover Silage for Replacement Heifers (J. H. Vandersall)
- 73 Nutritive Value of Direct-Cut Alfalfa Ensiled with Various Types and Levels of Newspaper (T. L. Horn and J. H. Vandersall)

SECTION X - ENVIRONMENTAL RESEARCH

- 75 Effect of Slope Orientation on Climate and Crop Growth (M. A. Sprague)
- 75 Handling and Utilizing Animal and Human Wastes in the Soil-Plant System (NE-110) (H. D. Bartlett and L. E. Lanyon)
- 77 Sudangrass Performance on Accumulated Surface Applied Sewage Sludge (R. W. Duell and S. W. Cosky)
- 77 Effects of Sewage Sludge on Soils and Yield of Corn and Soybeans (A. M. Decker and R. L. Chaney)
- 78 Feasibility of Using Sewage Sludge for Plant and Animal Production (A. M. Decker, J. P. Davidson, R. L. Chaney, S. B. Mohanty, and R. C. Hammond)

79 ... LIST OF PUBLICATIONS

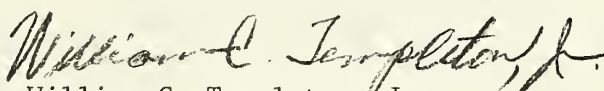
91 ... RECIPIENTS OF GRADUATE DEGREES

PREFACE

This report is intended, primarily, for use by forage research and extension personnel in Northeastern United States. Included are highlights of forage research activities at most of the agricultural experiment stations in the region and those of the Northeastern Region, Federal Research, Science and Education Administration, and Beltsville Agricultural Research Center, U.S. Department of Agriculture.

Appreciation is extended to the scientists and others whose contributions made the report possible. Special thanks are expressed to Mrs. Pattie Hite and Mrs. Amina Birkenmayer of the Pasture Laboratory staff, who assembled the original reports, retyped them, and saw the report through to its conclusion.

Continuing support and contributions from forage scientists of the region are solicited and encouraged to make the report as valuable as possible. We solicit continuing assistance in obtaining names of newly-arrived forage researchers, transfers, and retirees in the region to keep our records and mailing lists current. Also, suggestions concerning improvement and desirable changes will be appreciated.



William C. Templeton, Jr.
Director, U.S. Regional Pasture
Research Laboratory

AUTHOR INDEX

A

Allinson, D. W. (31, 32, 35)
Apgar, W. P. (56)

B

Baker, B. S. (36)
Baker, P. B. (14)
Balasko, J. A. (7)
Bartlett, H. D. (75)
Baylor, J. E. (43)
Baumgardt, B. R. (62, 68)
Beaudry, J. (35)
Berg, C. C. (19, 20)
Bond, J. (59)
Bowersox, T. W. (43)
Buckalew, J. M. (63)
Buric, J. (67)
Butler, Linda (18)
Byers, R. A. (10, 13, 14, 44)

C

Calvert, C. C. (60, 71)
Carlson, G. E. (23)
Carr, L. (67)
Carter, T. A. (67)
Chaney, R. L. (77, 78)
Chatterton, N. J. (23)
Clark, N. A. (45, 46)
Cleveland, R. W. (3, 4, 5, 62)
Cosky, S. W. (77)

D

Davidson, J. P. (78)
Decker, A. M. (45, 46, 77, 78)
DePeters, E. J. (63)
Dest, W. M. (27)
Dolan, D. D. (7)

Douglass, L. W. (66, 67)
Downs, W. G. III (40)
Dudley, R. F. (46)
Duell, R. W. (77)
Dunn, G. M. (5)

E

Elden, T. C. (2, 16)
Elgin, J. H., Jr. (1, 2)
Evans, J. L. (65)

F

Faust, R. M. (15, 16)
Fenner, H. (56)
Fiori, B. J. (16)
Fisher, D. D. (64)
Fissel, G. W. (68)
Flannery, R. L. (34, 36)
Fox, R. H. (38, 43)
Foy, C. D. (1, 3)

G

Goering, H. K. (58, 59)
Griffin, G. F. (33)
Gross, C. F. (25, 44)
Gustine, D. L. (25, 68)

H

Hagin, R. D. (28, 29)
Hammond, R. C. (66, 78)
Harmon, B. (67)
Hartwig, N. L. (27)
Hill, R. R., Jr. (10, 11, 21)
Holter, J. B. (69)
Hoover, M. R. (68)
Horn, T. L. (73)
Hower, A. A., Jr. (41)

I

Inskeep, E. K. (53)

J

Jung, G. A. (24, 25, 39, 44, 54)
Justin, J. R. (37)

K

Kendall, W. A. (14, 21, 23, 55)
Kesler, E. M. (63)
Kjelgaard, W. L. (40, 42, 49, 62)
Knieval, D. P. (40)
Krasnuk, M. (24)
Kunkle, W. E. (66, 67)
Kuykendall, L. D. (23)

L

Lanyon, L. E. (39, 75)
Lea, H. Z. (5)
Leath, K. T. (11, 19, 21, 41, 55)
Lee, D. L. (42)
Leffel, E. C. (66, 67)
Lelkes, Z. (65)
Lillquist, A. (32, 35)
Linscott, D. L. (28, 29, 46, 47)
Lootens, P. C. (42, 64)
Lucey, R. F. (29)

M

McCullough, C. (66)
McMurtrey, J. E. III (1, 2)
McNemar, J. H. (45, 46)
Moe, P. W. (57)
Mohanty, S. B. (78)
Morash, Susan (53)
Moyer, B. G. (68)
Mudgett, R. E. (50, 51)
Murray, J. J. (1, 3)

N

Nehrir, H. (42)
Nestor, R. L. (36)

O

Ostazeski, S. A. (2)
Owens, L. D. (23)

P

Partenheimer, E. J. (40)
Pearson, R. E. (70)
Pellett, P. L. (51)
Peters, R. A. (27)
Pfeffer, P. E. (68)
Plummer, J. A. (14)
Powell, J. B. (2, 3, 59)

R

Ratcliffe, R. H. (2, 14, 16)
Reed, H. E. (13)
Reid, R. L. (53, 54)
Reynolds, P. J. (57)
Risius, M. L. (3, 4, 5, 62)
Rowe, R. J. (50)
Rufner, R. (51)

S

Schaaf, H. M. (46)
Scholz, R. W. (64)
Shenk, J. S. (3, 4, 5, 55, 62, 68)
Sherring, W. R. (7)
Sherwood, R. T. (6, 19, 20, 21)
Simpson, M. E. (61)
Sloger, C. (23)
Slyter, L. L. (61)
Smith, A. M. (65)
Smith, L. W. (60)
Sprague, M. A. (37, 71, 75)
Stafford, R. F. (33)
Stringer, W. C. (36, 42, 43, 64)
Sullivan, W. M. (6)

T

Taylor, R. W. (31, 32, 35)
Templeton, W. C., Jr. (68)
Terrell, E. E. (1, 2)
Tyrrell, H. F. (57)

U

Ulrich, V. (39)

V

Valley, Karl (13)
Vandersall, J. H. (45, 72, 73)

W

Waldo, D. R. (58)
Wangsness, P. J. (62)
Washko, W. W. (31)
Weaver, J. E. (18)
Welch, J. G. (6, 35, 65)
Wells, G. D. (35)
Wengel, R. W. (33)
Witham, F. H. (24)
Wheeler, W. E. (59)
Whitney, L. F. (50)
Wilson, L. L. (42, 43, 64)
Wood, G. M. (6)

Y

Yoon, D. (65)
Young, B. A. (6)

Z

Zajac, P. (65)
Zeiders, K. E. (19, 20)
Zublena, J. P. (37)

ROSTER OF RESEARCH AND EXTENSION WORKERS IN NORTHEASTERN UNITED STATES WITH FORAGE CROPS AND GRASSLANDS ORIENTATION

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
-------------	--------------------------	-------------------

UNIVERSITY OF CONNECTICUT, Storrs, 06268

Allinson, D. W.	Forage Management	Plant Science
Cowan, W. A.	Animal Nutrition	Animal Industries
Dest, W. M.	Weed & Turf Invest.	Plant Science
Griffin, G. F.	Soil Fertility	Plant Science
Peters, R. A.	Weed Investigations	Plant Science
Washko, W. W.	Forage Management	Plant Science
Wengel, R. W.	Soil Physics	Plant Science

UNIVERSITY OF DELAWARE, Newark, 19711

Carroll, Robert B.	Plant Pathology	Plant Science
Fowler, R. E.	Beef Cattle Nutrition	Anim. Sci. & Agr. Biochemistry
Haenlein, G. F. W.	Nutritive Evaluation	Anim. Sci. & Agr. Biochemistry
Jones, E. R.	Forage Management	Delaware State College
Mitchell, W. H.	Forage Management	Plant Science
Reitnour, C. M.	Equine Physiology	Anim. Sci. & Agr. Biochemistry

UNIVERSITY OF MAINE, Orono, 04473

Apgar, W. P.	Forage Utilization	Anim. & Vet. Sciences
Forsythe, H. Y., Jr.	Forage Insects	Entomology
Holyoke, V. H.	Silage Corn Manag.	Plant & Soil Sciences
Rowe, R. J.	Engineering Harvesting	Engineering (Agr.)
Stafford, R. F.	Agronomy	Plant & Soil Sciences

UNIVERSITY OF MARYLAND, College Park, 20742

Clark, N. A.	Forage Management	Agronomy
Decker, A. M., Jr.	Forage Management	Agronomy
Kunkle, W. E.	Animal Nutrition	Animal Science
Leffel, E. C.	Animal Nutrition	Animal Science
Vandersall, J. H.	Dairy Nutrition	Dairy Science

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
UNIVERSITY OF MASSACHUSETTS, Amherst, 01002		
Fenner, Heinrich	Animal Nutrition	Vet. & Anim. Sciences
Mudgett, R.	Food & Agr. Eng.	Engineering (Food & Agr.)
Whitney, L. F.	Agr. Engineering	Engineering (Food & Agr.)
UNIVERSITY OF NEW HAMPSHIRE, Durham, 03824		
Byers, G. L.	Agr. Engineering	Inst. of Natural & Env. Resources
Dunn, G. M.	Forage Genetics	Plant Science
Estes, G. O.	Forage Nutrition	Plant Science
Fairchild, T. P.	Dairy Breeding	Animal Sciences
Frick, G. E.	Agr. Economics	Inst. of Natural & Env. Resources
Holter, J. B.	Dairy Nutrition	Animal Sciences
Koch, D. W.	Forage Plant Phys.	Plant Science
Mitchell, J. B.	Forage Management	Plant Science
Peirce, L. C.	Genet. Hort. Crops	Plant Science
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY, New Brunswick, 08903		
Duell, R. W.	Highway Vegetation	Soils & Crops
Evans, J. L.	Nutrition (Animal)	Animal Science
Flannery, R. L.	Soils	Soils & Crops
Halisky, P. M.	Plant Pathology	Plant Biology
Ilnicki, R. D.	Weed Control	Soils & Crops
Justin, J. R.	Farm Crops	Soils & Crops
Mears, D. R.	Agr. Engineering	Eng. (Biology & Agr.)
Race, S. R., Jr.	Forage Insects	Ent. & Econ. Zoology
Singley, M. E.	Engineering Util.	Eng. (Biology & Agr.)
Sprague, M. A.	Manag. & Preservation	Soils & Crops
CORNELL UNIVERSITY, (New York), Ithaca, 14853		
Campbell, J. K.	Agr. Engineering	Engineering (Agr.)
Duke, W. B.	Weed Control	Agronomy
Fick, G. W.	Forage Phys. & Manag.	Agronomy
Grunes, D. L.	Soils & Plant Nutr.	Agronomy (USDA-SEA)
Helgesen, R. G.	Entomology	Entomology
Linscott, D. L.	Weed Control	Agronomy (USDA-SEA)
Lowe, C. C.	Genetics & Breeding	Plant Breeding & Biom.
Millar, R. L.	Forage Diseases	Plant Pathology
Murphy, R. P.	Genetics & Breeding	Plant Breeding & Biom.
Reid, J. T.	Animal Nutrition	Animal Science

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
-------------	--------------------------	-------------------

CORNELL UNIVERSITY (Continued)

Schaaf, H. M.	Genetics & Breeding	Plant Breeding & Biom. (USDA-SEA)
Seaney, R. R.	Forage Management	Agronomy
Van Soest, P. J.	Animal Nutrition	Animal Science

NEW YORK STATE AGRICULTURAL EXPERIMENT STATION, Geneva, 14456

Dolan, D. D.	Plant Introduction	Seed & Veg. Sciences (USDA-SEA)
Flori, B. J.	Entomology	Entomology (USDA-SEA)
Sherring, W. R.	Seed Technology	Seed Investigations

THE PENNSYLVANIA STATE UNIVERSITY, University Park, 16802

Ace, D. L.	Dairy Extension	Dairy & Animal Science
Adams, R. S.	Dairy Extension	Dairy & Animal Science
Bartlett, H. D.	Agr. Engineering	Agr. Engineering
Baumgardt, B. R.	Animal Nutrition	Dairy & Animal Science
Baylor, J. E.	Pasture & Forage Crops	Agronomy Extension
Bloom, J. R.	Nematode Control	Plant Pathology
Buckalew, J. M.	Dairy Science	Dairy & Animal Science
Burdette, L. A.	Anim. Nutrition Ext.	Dairy & Animal Science
Cash, E. H.	Animal Nutrition	Dairy & Animal Science
Cleveland, R. W.	Genetics & Breeding	Agronomy
Cowan, R. L.	Animal Nutrition	Dairy & Animal Science
Downs, W. G., III	Forage Management	Agronomy (P.O. Rector)
Dum, S. A.	Farm Manag. Ext.	Economics
Fox, R. H.	Soil Fertility	Agronomy
Hartwig, N. L.	Weed Control	Agronomy
Hershberger, T. V.	Animal Nutrition	Dairy & Animal Science
Hower, A. A., Jr.	Forage Insects	Entomology
Johnson, M. W.	Corn Breeding	Agronomy
Kesler, E. M.	Dairy Science	Dairy & Animal Science
Kjelgaard, W. L.	Agr. Engineering	Agr. Engineering
Knieval, D. P.	Forage Physiology	Agronomy
Lanyon, L. E.	Soil Fertility	Agronomy
Long, T. A.	Animal Nutrition	Dairy & Animal Science
Lukezic, F. L.	Forage Pathology	Plant Pathology
McKee, G. W.	Crop Economics	Agronomy
Merritt, T. L.	Animal Science	Dairy & Animal Science
Partenheimer, E. J.	Agr. Economics	Agr. Econ. & Rural Soc.
Risius, M. L.	Genetics & Breeding	Agronomy
Shenk, J. S.	Forage Grass Breeding	Agronomy
Starling, J. L.	Genetics & Breeding	Agronomy
Stringer, W. C.	Forage Management	Agronomy

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
-------------	--------------------------	-------------------

THE PENNSYLVANIA STATE UNIVERSITY (Continued)

Thomas, W. I.	Representative, NE	Agr. Exp. Stations
Wangsness, P. J.	Animal Nutrition	Dairy & Animal Science
Wilson, L. L.	Animal Science	Dairy & Animal Science
Yendol, W. G.	Insect Control	Entomology

UNIVERSITY OF RHODE ISLAND, Kingston, 02881

Henderson, B. W., Jr.	Animal Nutrition	Animal Science
Wakefield, R. C.	Management	Plant & Soil Sciences

UNIVERSITY OF VERMONT, Burlington, 05401

Gotlieb, A. R.	Plant Pathology	Botany
MacCollom, G. B.	Entomology	Entomology
Smith, A. M.	Animal Nutrition	Animal Sciences
Welch, J. G.	Nutritional Value	Animal Sciences
Wood, G. M.	Forage & Turf Manag.	Plant & Soil Sciences

WEST VIRGINIA UNIVERSITY, Morgantown, 26506

Anderson, G. C.	Animal Nutrition	Anim. & Vet. Sciences
Baker, B. S.	Forage Management	Allegheny Highlands Project (Elkins, WV)
Balasko, J. A.	Forage Physiology	Plant Sciences
Bennett, O. L.	Forage Management	Plant Sciences (USDA-SEA)
Butler, Linda	Entomology	Plant Sciences
Diener, R. G.	Agr. Engineering	Resource Management
Elliott, E. S.	Root Diseases	Plant Sciences
Horvath, D. J.	Animal Nutrition	Anim. & Vet. Sciences
Keefer, R. F.	Soil Fertility	Plant Sciences
Reid, R. L.	Animal Nutrition	Anim. & Vet. Sciences
Thomas, R. O.	Dairy Nutrition	Anim. & Vet. Sciences
Toben, G. E.	Agr. Economics	Resource Management
Ulrich, V.	Plant Breeding	Plant Sciences

BELTSVILLE AGRICULTURAL RESEARCH CENTER, Northeastern Region, Federal Research, Science and Education Administration, U.S. Department of Agriculture, Beltsville, Maryland, 20705

Adams, J. R.	Entomology	Insect Pathology Lab
Barnes, R. F.	Forage and Range	National Program Staff
Bond, J.	Animal Science	Ruminant Nutrition Lab
Carlson, G. E.	Agronomy	Light & Plant Growth Lab

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
BELTSVILLE AGRICULTURAL RESEARCH CENTER (Continued)		
Calvert, C. C.	Animal Science	Feed Energy Cons. Lab
Chatterton, N. J.	Plant Physiology	Light & Plant Growth Lab
Coulson, J. R.	Entomology	Benef. Insect Intro. Lab
Dinius, D. A.	Animal Science	Ruminant Nutrition Lab
Dudley, R. F.	Agr. Engineering	Agr. Engineering
Elgin, J. H., Jr.	Agronomy	Field Crops Lab
Faust, R. M.	Entomology	Insect Pathology Lab
Feldmesser, J.	Zoology	Nematology Lab
Foote, R. H.	Agr. Admin.	Systematic Entom. Lab
Foy, C. D.	Soil Science	Plant Stress Lab
Goering, H. K.	Animal Science	Ruminant Nutrition Lab
Heimpel, A. M.	Entomology	Insect Pathology Lab
Hill, K. R.	Chemistry	Analytical Chem. Lab
Hooven, N. W., Jr.	Animal Science	Animal Operations
Howell, R. K.	Plant Pathology	Plant Stress Lab
Keys, J. E., Jr.	Animal Science	Feed Energy Cons. Lab
Klingman, D. L.	Weed Control	Weed Science
Kulik, M. M.	Plant Pathology	Seed Quality Lab
Lentz, P. L.	Botany	Mycology Lab
Louloudes, S. J.	Entomology	Insect Pathology Lab
Lynch, G. P.	Animal Science	Ruminant Nutrition Lab
Moe, P. W.	Animal Science	Ruminant Nutrition Lab
Murray, J. J.	Agronomy	Field Crops Lab
Norris, Karl	Laboratory Chief	Instrumentation Research
Oakes, A. J.	Agronomy	Germplasm Resources Lab
Ostazeski, S. A.	Plant Pathology	Field Crops Lab
Owens, L. D.	Plant Physiology	Plant Nutrition Lab
Pearson, R. E.	Animal Genetics	Genetics & Manag. Lab
Powell, J. B.	Genetics	Field Crops Lab
Ratcliffe, R. H.	Entomology	Field Crops Lab
Redfern, R. E.	Entomology	Biol. Eval. of Chemicals
Reynolds, P. J.	Animal Science	Ruminant Nutrition Lab
Rumsey, T. S.	Animal Science	Ruminant Nutrition Lab
Schechter, M. S.	Chemistry	Chem. & Biophys. Cons.
Schroder, R. F.	Entomology	Benef. Insect Intro. Lab
Simpson, M. E.	Plant Pathology	Feed Energy Cons. Lab
Slyter, L. L.	Chemistry	Feed Energy Cons. Lab
Smith, L. W.	Animal Science	Biol. Waste Manag. Lab
Terrell, E. E.	Botany	Plant Taxonomy Lab
Toole, V. K.	Plant Physiology	Seed Quality Lab
Tyrrell, H. F.	Animal Science	Ruminant Nutrition Lab
Waldo, D. R.	Animal Science	Ruminant Nutrition Lab
Wheeler, W. E.	Animal Science	Ruminant Nutrition Lab
White, G. A.	Laboratory Chief	Germplasm Resources Lab
Yaklich, R. W.	Plant Physiology	Seed Quality Lab

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
-------------	--------------------------	-------------------

U.S. REGIONAL PASTURE RESEARCH LABORATORY, North Atlantic Area,
Northeastern Region, Federal Research, Science and Education
Administration, U.S. Department of Agriculture, University Park,
Pennsylvania, 16802

Templeton, W. C., Jr.	Forage Crops Ecology	Laboratory Director
Berg, C. C.	Genetics (Grasses)	
Byers, R. A.	Forage Insects	
Fissel, G. W.	Chemistry	
Gross, C. F.	Soil Fertility	
Gustine, D. L.	Biochemistry	
Hill, R. R., Jr.	Genetics (Alfalfa)	
Jung, G. A.	Forage Management	
Kendall, W. A.	Plant Physiology	
Leath, K. T.	Pathology (Legumes)	
Sherwood, R. T.	Pathology (Grasses)	
Zeiders, K. E.	Plant Pathology	

SECTION I. BREEDING, GENETICS, AND PLANT INTRODUCTION RESEARCH

Title: Breeding Alfalfa for Tolerance to Aluminum Toxicity in Acid Soils

Leaders: J. H. Elgin, Jr., J. E. McMurtrey III, and C. D. Foy (Beltsville Agricultural Research Center)

Using nutrient culture techniques, we have developed an Al-tolerant alfalfa population for use on acid subsoils of Eastern United States. Although results are not yet available, field performance evaluations of the Al-tolerant population are now under way in Al-toxic acid soils in Virginia. In addition, mineral analyses of forage and root samples of the Al-tolerant population vs. standard checks grown in acid, Al-toxic nutrient culture have been completed.

Title: Scientific Names for Crop Plants

Leader: E. E. Terrell (Beltsville Agricultural Research Center)

One of the continuing functions of the Plant Taxonomy Laboratory is to provide correct, up-to-date scientific names for economic plants. During 1977, Agriculture Handbook 505 was published. This lists scientific names for 3,000 taxa, mostly species, plus 700 synonyms. Also listed are common names. This publication provides scientific names for major and minor crop plants grown anywhere in the world for food, fiber, or medicine. Also included are many timber and ornamental plants and many common weeds.

Title: Lime Responses of Kentucky Bluegrass and Tall Fescue Cultivars on an Acid, Aluminum-Toxic Soil

Leaders: J. J. Murray and C. D. Foy (Beltsville Agricultural Research Center)

To determine the relative response to lime levels (soil pH) among acid soil-sensitive and tolerant cultivars, 12 Kentucky bluegrass, and 7 tall fescue cultivars were grown on Tatum soil limed to six pH levels. Mean yield increased and soil Al concentration decreased as soil pH levels increased up to pH 7.4. Generally, the most acid-soil-tolerant Kentucky bluegrasses were also the most tolerant to alkaline-soil conditions. The most sensitive cultivars to acid-soil conditions were more exacting in soil pH range for maximum top yield. The response of tall fescue cultivars was different than that of bluegrasses. The most acid-soil-tolerant fescues were the most sensitive to alkaline soil conditions. Field plots on Tatum soil limed to four pH levels were established in the fall of 1977 to determine the relationship between laboratory and field response of cultivars.

Title: Taxonomy of Grasses of Tribe Triticeae

Leader: E. E. Terrell (Beltsville Agricultural Research Center)

During June and July 1977, collections for herbarium specimens were made of Agropyron, Elymus, and hybrid accessions grown by D. R. Dewey at Utah State University, Logan, Utah. These accessions came from all parts of the world and probably are the largest living collection of perennial Triticeae (formerly Hordeae) in existence. Morphological and other characteristics are being studied. One of the main purposes of study is to reassess relationships and generic alignments in this group of grasses.

Title: Forage Grass Breeding, Genetics, and Cytology

Leader: J. B. Powell (Beltsville Agricultural Research Center)

For the past few years we have continued to study anatomical and morphological traits of grasses which possibly can be used to increase the rate and extent of digestion. Evidence continues to accumulate which points to major opportunities to modify plant surfaces to improve rumen microbial penetration. Scanning electron microscopy reveals microbes colonizing surfaces on the waxy leaf of plants, indicating attachment is very important in the digestion process. Specific microbes may be responsible for attachment. The G1-4 mutant of Gateway barley is clearly different in allowing quicker penetration by microbes. The fundamental difference in the surface of the parental line from which the mutant arose is still being investigated. Emphasis on plant introductions of major forage grasses has continued with new lines of orchardgrass and tall fescue collected.

Title: Breeding Alfalfa for Disease and Insect Resistance

Leaders: J. H. Elgin, Jr., J. E. McMurtrey III, S. A. Ostazeski, R. H. Ratcliffe, and T. C. Elden (Beltsville Agricultural Research Center)

Intensive first-cycle field screening of adapted alfalfa for resistance to Fusarium oxysporum has been completed. Second-cycle screening and evaluation of first-cycle progress are planned for 1978.

A potato-leafhopper-resistant (PLH) population was developed from two Peruvian plant introductions (247789 and 247790) which were identified in 1976 as resistant in our field nursery of 925 PI's. Seed from the new population was planted at Beltsville in the spring of 1977 with several check entries. Good resistance was demonstrated by the PLH population during summer. Unfortunately, severe plant loss occurred during winter. Winter-hardy survivors have been selected for seed production in the greenhouse during 1978.

Title: Breeding Tall Fescue for Tolerance to Acid-Soil Conditions

Leaders: J. J. Murray, J. B. Powell, and C. D. Foy (Beltsville
Agricultural Research Center)

Wide variation for tolerance to acid Tatum soil among genotypes of tall fescue was found in greenhouse studies. This suggested the practicality of developing germplasm with greater tolerance to acid-soil conditions. Acid-soil-tolerant cultivars should be deeper rooted than currently available types, thus performing better under conditions of lower fertility and drought stress.

A recurrent selection program was initiated in 1976. Clones selected for cycle 2 will be intercrossed in the field this spring. Two methods of selecting for tolerance are being evaluated: (1) relative top yields of seedlings (45-day growth) in Tatum soil (pH 4.2); and (2) relative root production of vegetative cuttings in Tatum soil.

Title: Breeding of Perennial Forage Grasses

Leaders: J. S. Shenk, R. W. Cleveland, and M. L. Risius (The Pennsylvania State University)

The primary objective of this project is to develop a comprehensive breeding program to improve yield and quality of orchardgrass. Four different populations representing over 10,000 individual plants were obtained from foreign and domestic sources. Detailed studies of the individual spaced plants revealed that the most efficient method of evaluating newly introduced germplasm was by visual ratings of the overall desirability of spaced plants. Genetic studies indicated that family selection would be the best method to carry out the recurrent selection cycles over generations. Approximately 500 plants were selected from the original 10,000 and separated into two maturity groups. The selected plants were intercrossed in open-pollinated crossing blocks of 50 to 100 plants. The resulting seed was planted in small plots along with seed from the parental clones of Pennlate and Pennmead. Dry matter yield data were obtained from each small plot with a flail harvester. The forage was subsampled and analyzed for protein, digestibility, and fiber by infrared reflectance. The yield and quality data were analyzed by a computer Dairy Herd Simulation program to develop a selection index value for each entry. Plants were identified that were superior to those used in the Pennlate or Pennmead variety. These plants and others to be identified by further evaluation and testing will be compared to commercial varieties. This integrated approach using simplified field techniques and new infrared-computer technology should make a significant contribution to the development of new and better orchardgrass varieties for the livestock feeder.

Title: Breeding Crownvetch for Forage and Slope-Stabilization Usage

Leaders: M. L. Risius, J. S. Shenk, and R. W. Cleveland (The Pennsylvania State University)

Evaluation of crownvetch forage for beta-nitropropionic acid (BNPA), an antiquality forage constituent involving nonruminants, was continued. Nineteen Penngift crownvetch clones and their polycross progenies were studied at two locations in each of 2 years to evaluate genetic variation for BNPA. BNPA in parent clones ranged from 0.9 to 1.7% and 2.2 to 3.9%, respectively, in 1974 and 1975 at one location. Ranges were similar at a second location but slightly lower in magnitude. Range in BNPA level was smaller in the polycross families than in the parent clones. The estimate of total genetic variance for BNPA and the clone X year interaction were significant. No significant differences for BNPA were found among polycross families; interactions involving polycross families with locations or years were not significant. Nonadditive genetic variance was more important than additive genetic variance. Estimates of heritability were low (<25%). Progress in breeding for low levels of BNPA using these plant materials may be slow.

Forage from each of the crownvetch varieties (Penngift, Chemung, and Emerald) contained similar levels of BNPA. Relative relationships among crownvetch varieties for BNPA levels were similar over locations and harvests. There were significant location and harvest-time effects on BNPA levels.

A second cycle of selection for early-spring growth and rapid-recovery growth was started in plant introductions from Russia.

Title: Breeding Cool-Season Forage Species for Improved Feeding Value and Productivity

Leaders: R. W. Cleveland, M. L. Risius, and J. S. Shenk (The Pennsylvania State University)

Studies of the application of the infrared reflectance spectro-computer system (IRSCS) to forage breeding have been initiated using three harvests of open-pollinated progenies from 72 orchardgrass plants. Forage from plots was subsampled and ground through a 1 mm screen. To test the usefulness of IRSCS, each of the samples was analyzed in the laboratory for protein and in vitro dry matter disappearance (IVDMD). One-tenth of these samples were selected at random to develop calibration equations with IRSCS. The protein and IVDMD equations were tested for their prediction accuracy with the remaining nine-tenths of the samples. Standard error of predicting (SEP) protein was 0.71% and IVDMD 1.83%. Calibration equations were developed for the six filters proposed for forage quality analysis with commercial instruments. The SEP's for these equations were too large to be useful. Apparently, custom fitting is required for both wavelengths and coefficients to make prediction equations useful in breeding programs.

Nineteen Penngift crownvetch clones and their polycross progenies were evaluated to determine the nature of genetic variation for beta-nitropropionic acid (BNPA), an antiquality constituent in crownvetch forage. Nonadditive genetic variance for BNPA was more important than additive genetic variance. Broad- and narrow-sense heritability estimates were low (<25%).

Title: Breeding Red Clover and Alfalfa

Leaders: R. W. Cleveland, M. L. Risius, and J. S. Shenk (The Pennsylvania State University)

Red clover and alfalfa variety-trial yields were markedly reduced by drought conditions occurring before the first cutting in central and southeastern Pennsylvania, and throughout the growing season in the latter location. Differences among varieties did not occur to the extent expected. However, northern anthracnose-resistant red clover varieties continued to show yield advantage in central Pennsylvania.

A selection program was continued to develop creeping rooted alfalfa. Our lines, under evaluation in yield trials for the first year, showed vigorous aftermath growth and promise of acceptable yield performance. Superior creeping rooted alfalfa plants were identified for continuation of the breeding program.

Red clover populations were increased through seed production. These included strains that had been selected for resistance to northern anthracnose and powdery mildew, composite crosses of foreign and domestic strains, and selections of persistent plants from old red clover plantings.

Several new variety trials, plantings for evaluation of introductions, and seed production nurseries were established in 1977.

Title: Breeding and Genetics of Bromus inermis

Leaders: G. M. Dunn and H. Z. Lea (University of New Hampshire)

Approximately 500,000 seedlings were grown to determine inheritance of a rolled-leaf trait in B. inermis. It was inherited as a single tetrasomic recessive, with incomplete dominance for the normal allele. Thus, phenotypically rolled plants were represented by Rrrr or rrrr, normal plants by RRRR, RRRr, or RRrr. There was reduced transmission of the homozygous recessive gametes, especially through the pollen. Genetic studies are also in progress with a virescent gene obtained from R. P. Knowles, Saskatoon, Canada.

Title: Feasibility of Perennial Ryegrass and Hybrid Derivatives as Northern Forage Crops

Leaders: G. M. Wood, W. M. Sullivan, and J. G. Welch (University of Vermont)

Four short-term small container techniques were developed (see 1976 report, page 16) to screen grasses for cold tolerance as follows: (1) Grasses grown in plastic horticultural bulb pots buried flush in coarse gravel outdoors and allowed to overwinter; (2) Same as No. 1, except snowcover removed throughout winter; (3) Same as No. 2, except pots buried to lip in vermiculite and overwintered in an opensided unheated greenhouse; (4) Grasses grown in small flexible plastic pots embedded to the lip in moist soil or Styrofoam and gradually frozen in a large circulating-air chest-type freezer. Techniques 1 and 2 were found to be unsuitable in Vermont as short-term methods as no injury occurred when normal snowcover was present and no grasses survived when snow was removed. Techniques 3 and 4 showed promise for separating grasses with inherently very poor or very good cold hardiness. Either seedling or sod-growth stages are satisfactory for evaluations.

Based on laboratory and field data, new pasture plots were established to determine persistence and agronomic performance of selected perennial ryegrass cultivars. An attempt will also be made to correlate anatomical features of perennial ryegrass with cold hardiness.

Title: Physiological Control of Apomixis in Forage Grasses

Leaders: R. T. Sherwood (U.S. Regional Pasture Research Laboratory) and B. A. Young (The Pennsylvania State University)

A program was initiated to discover physiological or biochemical means for inducing apomictic reproduction in obligately sexual forage grasses and for inducing sexual reproduction in obligately apomictic forage grasses. A spaced planting was established of buffelgrass (*Cenchrus ciliaris*) lines that were obligately apomictic or were segregating for apomictic and sexual plants. Data were taken on morphological and agronomic characters. A technique was developed for rapidly classifying the type of embryo-sac development (sexual vs. apomictic) in flowers by clearing the pistils with methyl salicylate and examining them under interference-contrast microscopy. Using this method, we classified all the segregating population (>160 plants) for mode of reproduction. Young inflorescences of sexual and apomictic plants were treated with plant growth substances by infiltration or uptake. Near anthesis, the treated inflorescences were collected, killed, and fixed for observation to determine whether the growth substances affected embryo-sac development. Populations of apomictic and sexual dallisgrass (*Paspalum dilatatum*) from Texas were established in the greenhouse, and environmental conditions were found which induce flowering in the greenhouse.

Title: Genetic Variation of Nonstructural Carbohydrate Concentration in Tall Fescue (Festuca arundinacea Schreb.)

Leader: John A. Balasko (West Virginia University)

Forty-nine introductions of Festuca arundinacea Schreb. representing different regions of the world were acquired from the Western Regional Plant Introduction Station. One-hundred clones of most introductions and five varieties were established in a field nursery according to a randomized complete block design in summer 1977. Agronomic data and samples for chemical analysis were taken during late summer. The clones will be screened for nonstructural carbohydrate and alkaloid concentrations. Plants from this nursery will serve as a source nursery for propagating clones for future experiments.

Title: Forage Crop Introductions

Leaders: D. D. Dolan and W. R. Sherring (Geneva, New York)

ALFALFA (Medicago sativa). On May 10, 1977, notes were taken on winter hardiness and spring recovery of 45 alfalfa introductions carried over from 1976. At that time, 20 introductions of Medicago sativa and nine introductions of Medicago falcata appeared to have good winter hardiness, excellent spring recovery, and to be worthy of further trial.

The introductions of Medicago sativa are: P.I. 170445 Tur., 170450 Tur., 174271 Tur., 187004 Iowa, 188868 Can., 198962 Cyprus, 199272-75 Port., 204591 Tur., 205198 Tur., 206286 Tur., 206451 Tur., 206698 Tur., 208115 Afgh., 212798 Iran, 212858 Afgh., 212860 Afgh., and 212861 Afgh.

The following are the nine promising numbers of Medicago falcata: P.I. 258754 USSR, 314579 USSR, 325384 USSR, 384507 USSR, G-14067 S. Dakota, G-22122 Bulg., G-23582 Ger., G-23583 USSR, and G-23584 USSR.

RED CLOVER (Trifolium pratense). When the 1977 evaluation notes were complete, we prepared a composite catalog of all the red clover introductions grown and described in 1976 and 1977. These introductions have been rated for type of plant (medium or mammoth), uniformity, habit, vigor, plant height, plant width, number of stems, size of stems, leafiness, earliness of bloom, number of heads setting seed, susceptibility to powdery mildew, susceptibility to virus, fall recovery after cutting, winter survival, and spring recovery.

In some cases, stands were considerably reduced by the second year, but the following eight introductions rated vigorous and leafy, produced a satisfactory forage yield, and should be further tested in the northeast region: P.I. 174775 Swe., 235862 Swe., 401469 Rum., 403970 USSR, 403971 USSR, 406325 USSR, 406640 Fr., and 406641 Fr.

The 1977 growing season was unusually wet, and some of our stand thinning was definitely due to root rot.

Notes taken on percentage winter survival and spring recovery on May 10, 1977, indicated that the following nine introductions of red clover are well adapted and should be further tested in the northeast region: P.I. 199775 Swe., 234839 Ger., 234925 Switz., 281910 USA, 303074 Fin., 304840 Nor., and three different G numbers: G-21636, G-24103, and G-24104.

On May 10, 1977, winter survival and spring growth recovery notes were taken on approximately 30 red clover introductions carried over from 1976. The following eight introductions had exceptionally good survival into the second year, made good spring growth, and should be further tested: P.I. 199775 Swe., 234839 Ger., 234925 Switz., 281910 USA, 303074 Fin., 314840 Nor., G-24103 Tenn., G-24104 Ky.

Six introductions of Trifolium ambiguum also appeared promising and worthy of further trial: P.I. 405120 USSR, 405121 USSR, 405122 USSR, 405123 USSR, 405124 USSR, and 405935 Australia.

P.I. 234839--Plants of this particular red clover introduction were set out in the field in the spring of 1976. A high percentage of the plants persisted to the fall of 1977 and appeared vigorous and leafy at that time. This introduction came from Germany.

In our 1976 red clover planting, we included Kentucky Synthetic A-2. This is carried as FC 40260 and G-21636. At the end of its second season in the fall of 1977, it was definitely the most persistent and the most vigorous and leafy red clover in the entire planting. It was better than any plant introduction.

WHITE CLOVER (Trifolium repens). In the last half of June 1977 and up to July 10, evaluation notes were taken on white clover introductions. Each introduction was rated for type, uniformity, vigor, plant size, degree of spread, leafiness, time of bloom, seed set, and degree of damage due to leafhopper and leafminer. The following 16 introductions of white clover proved vigorous and leafy at Geneva and should be further tested: P.I. 181812 Leb., 206302 Tur., 228366 Iran, 231784 N.H., 231785 N.H., 231786 N.H., 231789 N.H., 232110 Ger., 232113 Ger., 233746 Italy, 234840 Ger., 234934 Switz., 237732 Ger., 250998 Yugo., 251190 Yugo., and 251191 Yugo.

STRAWBERRY CLOVER (Trifolium fragiferum). Four strawberry clover introductions appeared to be vigorous, leafy, and strong spreaders and probably should be further tested for soil conservation use: P.I. 250987 Yugo., 254916 Iraq, 316352 Austral., and 369038 Czech.

Of all the strawberry clovers in the 1976 planting, the most outstanding was the cultivar 'Salina' FC 40810 or G-22501. At the end of its second year of growth, the fall of 1977, it was noted to have a taller habit than any other accession in the planting and also to be a vigorous, leafy, strong spreader.

Another strawberry clover from the USSR (P.I. 316352) was noted to have the best winter hardiness and the best spring recovery in the spring of 1977.

Three introductions of strawberry clover were noted to have excellent fall growth toward the end of their second year. These are: P.I. 369307 Port., 369038 Czech., and 369039 Israel.

BIRDSFOOT TREFOIL (*Lotus corniculatus*). During the interval mid-June to July 1977, notes were taken on various characteristics of trefoil introductions. Six that were most vigorous, leafy, and persistent and should be further tested for use as forage are: P.I. 228233 Italy, 230332 Tur., 235101 Swe., 244036 Brazil, 304280 Urug., and 383690 Tur.

TALL OATGRASS (*Arrhenatherum elatius*). This year we prepared a cumulative catalog of all the tall oatgrass introductions grown and seed increased to the present time. In addition to the P.I. number in the left-hand column and the country of origin, this cumulative catalog contains ratings of plant characteristics as follows: uniformity, habit, vigor, culm height, leaf type, plant width, number of culms, size of culms, leafiness, distribution of leaves, basal, cauline or distributed, size of leaves, color of leaves, time of bloom, number of heads set, susceptibility to leafspot, susceptibility to rust, fall recovery after cutting, winter survival, and spring recovery.

The following 44 tall oatgrasses proved to be vigorous, leafy, late blooming, had good winter survival and spring recovery, and should be further tested in the Northeast Region: P.I. 186791 Wyom., 194699 Neth., 202273 Chile, 234461 Spain, 234462 Spain, 234464 Spain, 234465 Spain, 234687 Den., 234710 Fr., 235456 Switz., 235543 Swe., 237173 Neth., 237706 Ger., 249720 Gre., 249916 Port., 251571 Yugo., 251572 Yugo., 251573 Yugo., 251801 Austria, 251946 Austria, 253292 Yugo., 255165 Pol., 255166 Pol., 255399 Yugo., 255402 Yugo., 255404 Yugo., 255406 Yugo., 255407 Yugo., 283185 Austral., 283187 Austral., 283188 Austral., 288924 Hung., 288926 Hung., 288927 Hung., 292848 E. Ger., 302854 Spain, 303816 Can., 311017 Rum., 314410 USSR, 316159 Austral., 316160 Austral., 318940 Spain, 323488 USA, 323489 USA.

Two introductions of tall oatgrass appeared to be sufficiently vigorous, leafy, and late blooming to be worthy of further trial as forage grasses. These are: P.I. 251572 Yugo. and 406308 USSR.

TIMOTHY (*Phleum pratense*). Only four of the timothy introductions evaluated in 1977 were sufficiently vigorous, leafy, and late blooming to be worthy of further testing as forage grasses. These are: P.I. 406317-19 USSR and 406321 USSR.

PERENNIAL RYEGRASS (*Lolium perenne*). The complete collection of perennial ryegrasses was screened in a field planting for tolerance or resistance to crown rust caused by *Puccinia coronata*. Each individual plant and three replicated rod rows were scored for rust infection on a scale of 0 to 9 (0 indicating no infection and 9 indicating severe infection).

At the end of the second year of the test, the following 16 introductions had the lowest rating of rust infection, that is, an average rating of less than 2.5: P.I. 189154, 189156, 189392, 196423, 201185, 231573, 231592, 231601, 231620, 251667, 272171, 274637, 290374, 303041, 303014, and 303049.

The following 35 perennial ryegrasses were scored second best, that is, having an average rust-infection rating from 2.5 to 5.0: P.I. 187221, 189153-55, 189157, 189397, 196422, 197270, 198958, 200322, 201188-90, 202451, 204879, 220528, 222527, 223178, 230260, 231565, 231571-72, 231576, 231589, 231594-95, 231606, 241608, 268333, 278704, 290369-70, 303015, 303023, and 303042.

Rated for persistence, vigor, and leafiness, the most attractive 34 perennial ryegrass introductions are: P.I. 196423, 231581, 231589-90, 231594-96, 231600-02, 231604-05, 234441, 237185, 255175, 265343, 266291, 268333, 272121, 278704, 287849, 290372-74, 303012-14, 303021-23, 303032, 303038, 303049, and 306692.

With regard to potential use, there were three pasture-type perennial ryegrasses: P.I. 231594, 234441, and 290373.

There were three perennial ryegrasses of the lawn type: P.I. 231590, 290373, and 303032.

There was one perennial ryegrass of the prostrate type: P.I. 231602.

Title: Genetic Variability for Reaction to Agromyza frontella (Rondani) in Medicago sativa L.

Leaders: R. R. Hill, Jr., and R. A. Byers (U.S. Regional Pasture Research Laboratory)

Sixteen plants from each of 54 polycross families of alfalfa, Medicago sativa L., were evaluated for reaction to the alfalfa blotch leafminer, Agromyza frontella (Rondani). Reaction to the insect was measured as the number of mined leaflets in a sample of 30 leaflets from each plant on first harvest and later season forage in 1976 and 1977. Estimates of variance components were used to calculate heritability and estimated gain from mass, half-sib family, and modified ear-to-row selection.

Variability among families was significant, but the heritability estimate was low (4.18%). When the overall selection intensity was high, the modified ear-to-row procedure was more effective than mass selection only when the number of replications was large and the selection intensity within families was moderate. Mass selection was more effective when the number of replications was low and selection intensity within families was very low or very high. The efficiency of mass selection increased relative to that of the other methods when the overall selection intensity decreased. The modified ear-to-row procedure with high selection intensity was recommended for increasing resistance to A. frontella in M. sativa.

Title: Selection for Resistance to Leptosphaerulina Briosiana in Alfalfa

Leaders: R. R. Hill, Jr., and K. T. Leath (U.S. Regional Pasture Research Laboratory)

Three cycles of selection for resistance to Leptosphaerulina briosiana (Poll.) Graham and Luttrell were conducted in two alfalfa (Medicago sativa) germplasm pools, MSA, and MSB. Four methods of selection, phenotypic recurrent, half-sib family, full-sib family, and alternating generations of selfed family and half-sib family were compared in each germplasm pool.

Response to selection for resistance to L. briosiana was greater in MSA than in MSB, and differences between selection methods were not significant. Selection for resistance to L. briosiana generally increased resistance to Stemphylium botryosum Wallr., but the magnitude of the correlated response varied with germplasm pool and selection method. Resistance to Colletotrichum trifolii Bain and Essary decreased with selfed family selection for resistance to L. briosiana.

SECTION II. ENTOMOLOGY RESEARCH

Title: Economic Injury Level for Alfalfa Blotch Leafminer

Leaders: R. A. Byers (U.S. Regional Pasture Research Laboratory) and
Karl Valley (Pennsylvania Department of Agriculture)

One mine per leaflet reduced crude protein, in vitro dry matter disappearance (IVDMD), and dry weight of leaflets. Most important was the loss in crude protein, one mine per leaflet, causing a reduction of 8.86%. An overall loss of 2% protein occurs whenever 22% of the leaflets have one mine per leaf. Replacement of a loss of 2% protein with soybean meal would cost approximately \$13/acre. Insect control to prevent the protein loss caused by the leafminer would cost approximately \$13/acre (\$7 for insecticide, \$6 for application). Consequently, 2% loss of protein is the break-even point. Losses above this level become economically important. At the above prices, the economic injury level for the alfalfa blotch leafminer, therefore, is approximately 22% of the alfalfa leaflets with at least one blotch mine.

Title: Flea Beetle Control on Sod-Seeded Kale and Turnips

Leaders: H. E. Reed (The Pennsylvania State University) and R. A. Byers
(U.S. Regional Pasture Research Laboratory)

Kale and turnips were sod seeded at two locations in Pennsylvania. Carbofuran (10% granules at 2 lb ai/a) was applied to the sod immediately after planting. Dry weather following planting retarded germination. Flea beetles averaged 14.5/10 sweeps in untreated plots, and 8.1/10 sweeps in carbofuran treatments.

There were an average of 7.1 and 15.5 flea beetles/10 sweeps on turnips and kale, respectively. Turnips averaged 3.0 plants/meter of row and kale 5.3 plants/meter. No difference in stands resulted from the carbofuran treatment.

Kale was planted in August by conventional tillage methods in pure stands. Carbofuran was again applied immediately after planting. There were significant differences between treated and untreated plots for the following parameters: plant height, 76.7 cm (treated, 59.4 cm (untreated)); dry matter yield, 3,910 kg/ha, 2,490 kg/ha; yield of digestible dry matter, 3,240 kg/ha, 2,110 kg/ha; crude protein yield, 770 kg/ha, 530 kg/ha; and plants/meter, 5.3, 3.4, respectively. These data show that flea beetles are a major deterrent to establishment, growth, and yield of kale and turnips as forage crops.

Title: Life Table for the Alfalfa Blotch Leafminer

Leaders: J. A. Plummer (The Pennsylvania State University) and
R. A. Byers (U.S. Regional Pasture Research Laboratory)

Alfalfa was sampled on 27 different dates in 1977 for all stages of the insect. Highest egg numbers occurred in May. Highest numbers of larvae, pupae, and adults were collected in the generation with the most eggs. There were four population peaks during the season, the highest peak (50% of leaves mined) occurring from the first generation. Large numbers of eggs deposited, plus low rainfall during the egg-development stage and few larval parasites, explained the peak of the first generation. Heavy rainfall during the oviposition period and many parasitized larvae explained the low peaks of the next three generations. These results are unusual, as in the 3 years prior to 1977, the second generation had the highest numbers of larvae, pupae, and adults.

Title: Host Preference of Sitona Larvae among Legumes

Leaders: R. A. Byers and W. A. Kendall (U.S. Regional Pasture Research Laboratory)

A nutrient-slant-board technique was used to test DuPuits alfalfa, Penngift crownvetch, Kenland red clover, Merit white clover, and Leo birdsfoot trefoil against larvae of Sitona hispidulus and another insect, S. flavescens. Leo birdsfoot trefoil and Penngift crownvetch were resistant to both insects, while DuPuits alfalfa was resistant to S. flavescens, but not to S. hispidulus. Kenland red clover and Merit white clover were susceptible to both species.

Title: Selection for Hairy Chinch Bug Resistance in Cool-Season Grasses

Leaders: R. H. Ratcliffe (Beltsville Agricultural Research Center) and
P. B. Baker (University of Maryland)

A laboratory method has been developed for evaluating cool-season grasses for tolerance to the hairy chinch bug. Plants are grown in 15 cm pots and tested when 1 month old. During infestation they are confined in a plastic cylindrical cage constructed so that half of the plants in each pot are infested and half remain uninfested. After approximately 17 days of feeding, insects are removed, and regrowth, yield, percent dry matter, root development, plant survival, and tillering are recorded. The tolerance of each cultivar or line is determined on the basis of the difference in response between infested and uninfested plants in the same pot. To date, 22 Kentucky bluegrass cultivars have been evaluated for tolerance to adult feeding. Significant differences in regrowth, yield, percent dry matter, and plant survival were recorded among cultivars, indicating that these may be useful criteria for measuring tolerance.

Title: An Isolated Strain of Bacillus thuringiensis that Imparts Pathogenicity to Several Mosquito Species and Corn Rootworm (Diabrotica) Species

Leader: Robert M. Faust (Beltsville Agricultural Research Center)

A strain of Bacillus thuringiensis that produces toxic cuboidal parasporal crystals has been isolated and shown to be toxic to several genera of mosquito larvae (Culex, Culiseta, Aedes, Orthopodomyia) and to southern corn rootworm larvae (Diabrotica undecimpunctata howardi). In laboratory tests, 70 to 100% mortality within 48 hours of early stage larvae feeding on corn shoots was obtained. Similar results were obtained with oral injections of 14-day-old larvae. Fresh artificial adult-beetle diet was also treated with a solution of spore-crystal mix and offered as food to the caged beetles. Adult beetles were not susceptible to the B. thuringiensis strain. Affected larvae showed typical symptoms of B. thuringiensis intoxication (i.e., sluggishness, cessation of feeding, regurgitation, diarrhea, and finally, darkening of the integument at death). Corn rootworms are perhaps the most important corn pest in the upper Mississippi Valley, and resistance to chemical insecticides is a serious problem. Investigations into the mode of action and efficacy of this B. thuringiensis strain in field tests is a major goal in developing this organism as a control agent against corn rootworms.

Title: Plasmid DNA of Bacillus thuringiensis var. kurstaki, var. sotto and Bacillus popilliae

Leader: Robert M. Faust (Beltsville Agricultural Research Center)

Two varieties of Bacillus thuringiensis and the Japanese beetle pathogen Bacillus popilliae isolated from diseased larvae have been shown to possess extrachromosomal DNA's by agarose gel electrophoresis analysis. After further investigations, a total of 12 extrachromosomal elements were identified from B. thuringiensis var. kurstaki, four of which were giant plasmids ($>50, 45, 29.9, 17.1 \times 10^6$ daltons). The smaller plasmids ranged from 0.74 to 7.4×10^6 daltons. In contrast, B. thuringiensis var. sotto contained only one giant plasmid (23.5×10^6 daltons) and two small extrachromosomal DNA elements (0.62 and 0.80×10^6 daltons). B. popilliae contained two small extrachromosomal DNA elements (0.58 and 4.45×10^6 daltons). While the phenotypic properties conferred remain speculative, we are further conducting restriction mapping and testing the possibilities of conjugal donor ability, drug resistance, parasporal-body production, and virulence enhancement. These studies may have important implications in development of broad-spectrum insect control agents for forage-insect pests and in enhancing fermentation ability, in vitro sporulation, and commercial production of B. popilliae with recombinant DNA technology.

Title: Selection for Potato Leafhopper Resistance in Alfalfa

Leaders: T. C. Elden and R. H. Ratcliffe (Beltsville Agricultural Research Center)

Plants of 930 Medicago sativa lines were evaluated for resistance to potato leafhopper yellowing in a field nursery in 1977. Seventy of these lines were sampled three times during the growing season for nymphal populations. Several lines supported small or no nymphal populations and showed less yellowing. Cuttings of 40 lines were made and presently are being grown in the greenhouse for laboratory evaluation. Laboratory tests were conducted with a Hairy Peruvian type selected as more tolerant to leafhopper yellowing in 1976. These tests demonstrated that female leafhoppers preferred more glabrous alfalfa (Arc) to highly pubescent alfalfa (Hairy Peruvian) for oviposition when offered a choice; however, there was no difference in the number of eggs laid in each when the females had no choice. There was no reduction in egg hatch or nymphal survival on the Hairy Peruvian alfalfa, indicating no antibiosis to potato leafhopper in this material.

Title: Catabolic Efficiency of Bacillus popilliae, the Japanese Beetle Pathogen, under Aerobic and Anaerobic Conditions

Leader: Robert M. Faust (Beltsville Agricultural Research Center)

Complete information about the effects of cultural conditions on metabolic cycles in this important insect pathogen is crucial to in vitro growth and sporulation investigations. B. popilliae utilizes a normal glycolytic and Krebs tricarboxylic acid cycle but contains an incomplete electron transport system.

This study was undertaken to determine the system of catabolism in B. popilliae. In this study, glucose uptake, ATP levels, and total cell biosynthetic yield were determined under aerobic and anaerobic conditions. No shift in metabolic efficiency under anaerobic conditions was observed, which indicated that B. popilliae is a completely fermentative organism and is an aerotolerant anaerobe.

Title: Supplement III to Annual Report of NE-9 for 1977, Entomology Report

Leader: B. J. Fiori (Geneva, New York)

Eighty-six alfalfa accessions (62 Medicago sativa, 16 M. falcata, 2 M. pirone, 6 hybrids) reported as having some potato leafhopper resistance were planted during May in a twice replicated, completely randomized, choice test. The test contained 18 plants per replicate; spacing was 6' x 1' + 5'. Leafhopper damage was rated on July 22, 1977, with a

subjective scale of 1 to 10 (10 being the most severe damage). After rating, all accessions receiving a 6 or less in both replications, and the standards, were mowed. One plant of each replication was caged and 30 field-collected leafhopper adults were placed in each cage (no choice test). On August 16 (24 days after cutting), plant growth (total length) was taken on 10 plants in each replicate. On October 11 (81 days after cutting), plant growth and other observations were taken.

The following accessions were found resistant in the choice test. Ratings immediately follow P.I. numbers and indicate degree of resistance and replicate uniformity. Standards are given for comparison. P.I. 172984, 5, 4; 231731 Wisconsin 460, 4, -; 251688, 2, 3; 251689, 5, 2; 251830, 2, 3; 258950, 2, 2; 258751, 1, 1; 258752, 4, 6; 258754, 3, 4; 262532, 4, 4; 263154, 5, 3; 'Kuban Yellow' M. falcata P.I. 253449, 1, 1; 253450, 1, -; M. pironae P.I. 277883, 4, -; Gaetula M. sativa. Indiana Synthetic C, 4, 3; - hybrid. Cayuga, 8, 7; Saranac, 8, 8; Iroquois, 10, 10.

In comparison to Saranac, all resistant accessions including Indiana Synthetic C were slower in regrowth 24 days after cutting. Among resistant accessions, Indiana Synthetic C was most superior in regrowth, P.I. 253449 and 253450 were most inferior.

At 81 days after cutting P.I. 172981, 251689, 258754, 262532, 263154, 277883, and Indiana Synthetic C were comparable to Saranac in plant growth. P.I. 172981 had a very spreading growth habit; 251689, 258754, 262532, and 263154 had a spreading growth habit; P.I. 277883 and Indiana Synthetic C had an erect growth habit.

Caged (no choice) tests were inconclusive.

Of the alfalfas tested, it appears that P.I. 277883 'Gaetula' and Indiana Synthetic C offer the most promise as resistant (choice test), phenotypically desirable parents or varieties. It is interesting to note that: (1) P.I. 172984 has continued to show resistance (choice test) for three seasons. (2) Of 16 M. falcata tested, 11 (68%) were resistant but only 1 (1.6%) of 62 M. sativa was resistant (choice test). (3) M. pironae offers high resistance but is phenotypically undesirable. (4) of 86 accessions previously reported as resistant, only 14 (16%) were resistant in this test.

Title: Control and Bionomical Studies of Livestock and Animal Food Crop Insects in West Virginia

Leaders: Linda Butler and J. E. Weaver (West Virginia University)

Further studies on effects of dyes offered ad libitum to houseflies in enclosed rooms with 24-hour lighting showed mortality rates of 76 to 94% after 3 to 4 days for erythrosin B baits and 70 to 84% after 6 to 7 days for rose bengal baits; mortality was generally higher and occurred more rapidly in rooms with green light.

Although the alfalfa weevil parasite, Bathyplectes anurus, is established at most release sites in 16 counties, populations remain very low; the species appears to be doing best in fields at higher elevations.

Work was completed on evaluation of insect-growth regulators against alfalfa pests. Highly significant mortality was observed in alfalfa-weevil larvae and pupae treated with TH 6040. TH 6041 also gave high mortality. An experimental carbamate, RO 11-8868, was evaluated at two rates against alfalfa-weevil larvae. The compound was extremely effective in producing mortality, comparing favorably with results for carbofuran.

Continued studies of distribution of Tabanidae in West Virginia resulted in four new state records and 143 new county records. Continual malaise trapping from July 1 through September near an anaplasmosis-infected cattle herd in Hardy County revealed significant numbers of Tabanus quinquevittatus, a potential vector of the disease.

Research was completed on effect of the adjuvant Regulaid in increasing mortality levels in malathion-treated houseflies. Regulaid apparently prevents detoxification of malathion by the hydrolytic enzymes of houseflies.

SECTION III. PLANT PATHOLOGY RESEARCH

Title: First Report of Alfalfa Crownwart in the Northeast

Leader: K. T. Leath (U.S. Regional Pasture Research Laboratory)

Crownwart is a disease of alfalfa caused by the chytrid fungus, Physotherma alfalfae (Lagh.) Karling. The fungus invades crown buds and induces hypertrophy of the developing shoot tissues. Crownwart occurs most commonly on alfalfa grown under irrigation in our western states and also in Europe, Australia, and New Zealand. It has not been reported to occur in Northeastern United States, although it was found in Alabama.

Alfalfa plants were dug from fields in Westmoreland County in southwestern Pennsylvania on a triweekly basis from 30 March to 5 October 1977, as part of a root-disease survey. Crownwart was observed first on plants dug from one field on 11 May. Diseased plants from the same field were found on 1 June, 22 June, and 13 July. Throughout June, galls were firm and white; by 13 July, galls were turning brown and deteriorating. Only one intact gall was found on roots dug on 3 August.

In June, crownwart was found on alfalfa on two other farms within 5 miles of the original disease site. All fields in which crownwart occurred were low lying and poorly drained.

In the original field, disease incidence ranged from 10 to 40% of the plants sampled on each date. Galls numbered from one to eight per plant and measured from 3 to 22 mm across the longest dimension. Because this pathogen cannot be cultured, diagnosis was based upon the characteristics of the galls and on the presence, within the galls, of chlamydospores that matched for color, appearance, and size those described by earlier workers.

The finding of crownwart in Pennsylvania represents a significant extension of its geographic range. The disease is not considered to be serious, and no effect of the disease on yield or stand was evident during the 1977 growing season. Because of the high incidence of diseased plants at 3 locations, it is likely that crownwart has occurred other years in this area.

Title: Resistance to Purple Leafspot in Orchardgrass

Leaders: K. E. Zeiders, C. C. Berg, and R. T. Sherwood (U.S. Regional Pasture Research Laboratory)

The third cycle of recurrent phenotypic selection, using polycross seed produced in the field in 1976, was completed; and 178 of the most resistant genotypes with good seedling vigor were tillered and set in the field on July 29, 1977, for seed production in 1978. Greenhouse screening revealed highly significant differences among clones for reaction to purple leafspot.

Title: Resistance to Brown Leafspot in Smooth Bromeass

Leaders: K. E. Zeiders, C. C. Berg, and R. T. Sherwood (U.S. Regional Pasture Research Laboratory)

This program of recurrent phenotypic selection was started by screening a base population consisting of 93 plant introductions obtained from the Plant Introduction Station at Ames, Iowa, and five commercial cultivars for resistance to Pyrenophora (Helminthosporium) bromi. Two cycles of selection have been completed and polycross seed for a third cycle was harvested in July 1977 from 111 of the most resistant clones from cycle two in a replicated field planting. There were significant differences among clones for naturally occurring brown leafspot in this nursery. Sixty-seven percent of the clones had mean ratings of 4.0 or lower on a 1 to 9 scale, indicating slight or slight-to-moderate disease. This population also contained considerable variability for agronomic traits (plant height, plant size, extent of rhizome production, etc.).

Title: Diseases of Warm- and Cool-Season Forage Grasses

Leader: K. E. Zeiders (U.S. Regional Pasture Research Laboratory)

In 1977, the severity of leaf disease on switchgrass and big bluestem varieties in Huntingdon County, Pa., was rated on August 31 and September 28, using a 1 to 9 scale. Big bluestem was also rated on July 27. Leaf-spot on Kaw big bluestem averaged 6.3 (severe) over the three ratings, while NY-1145 and Ky-599 averaged 3.8 and 3.9, respectively (slight to moderate). Of six varieties of switchgrass, five were moderately to highly susceptible to spotblotch (range 5.8 to 7.2) caused by Helminthosporium sativum. Ky-729, however, had only slight disease (mean 3.2), which is consistent with its mean rating of 2.3 for 1976. The conclusion from 2 years of observations is that Ky-729 has good field resistance or tolerance compared with the varieties Carthage, Blackwell, and three New York breeding lines, which were susceptible in 1977. Plants of Ky-729 were larger than the other switchgrass entries, and probably would outyield the others. Varieties of little bluestem, caucasian bluestem, and indiagrass had little or no disease, as in 1976. A species of Helminthosporium was isolated from leafspots on Tioga deertongue grass.

In artificial inoculations, Helminthosporium isolates from switchgrass and deertongue were moderately to highly pathogenic on switchgrass, deertongue, sudangrass, reed canarygrass, indiagrass, and rice. Caucasian bluestem was not attacked. An isolate of H. sativum obtained from switchgrass in Mifflin County, Pa., was much less virulent than the switchgrass isolates from Huntingdon County in two separate inoculation tests. This difference in aggressiveness among strains of the fungus could account for differences in the prevalence and severity of disease.

Isolates of Ascochyta brachypodii and a species of Mycosphaerella from leafspots on big bluestem were moderately to severely pathogenic on big bluestem, corn, and sudangrass. Caucasian bluestem and old world bluestem were resistant to these fungi. Switchgrass and oats were mildly attacked by Mycosphaerella.

In 1976, Helminthosporium triseptatum was isolated from blighted orchardgrass, and Curvularia lunata from blighted timothy at the Huntingdon County, Pa., plots. In artificial inoculations, both orchardgrass and timothy were susceptible to H. triseptatum, while only timothy, the original host, was susceptible to C. lunata. Corn, oats, wheat, barley, rice, and seven forage grasses were resistant to H. triseptatum. Switchgrass was slightly susceptible. Four forage grasses were resistant to C. lunata.

Title: Papilla Mechanism of Resistance of Grasses to Leafspot Fungi

Leader: R. T. Sherwood (U.S. Regional Pasture Research Laboratory)

Additional evidence was obtained that supports the hypothesis that appositional wall formation is an important mechanism of resistance to fungal penetration in the grass family. Leaves of species representative of 11 major tribes of Gramineae were inoculated with Stemphylium botryosum, Curvularia lunata, or Helminthosporium maydis race T. The species tested were timothy, big bluestem, oats, bermudagrass, smooth bromegrass, barley, wheat, rice, switchgrass, reed canarygrass, corn, and Japanese lawnglass. All species readily formed appositional walls at the sites where the fungi attempted to penetrate, and >95% of the penetration attempts were unsuccessful. Treatment with cycloheximide inhibited appositional wall formation and permitted penetration indicating that resistance is inducible. There appeared to be a separate constitutive mechanism of resistance in rice, bermudagrass, and Japanese lawnglass that was associated with the structure of the epidermis.

Title: Methods to Evaluate Responses of Red Clover to Specific Fusaria

Leaders: K. T. Leath, W. A. Kendall, and R. R. Hill, Jr. (U.S. Regional Pasture Research Laboratory)

Several species of Fusarium have been implicated in the crown and root rot complex of red clover. For this reason, selection for resistance has been indirect, relying mainly upon field persistence. We developed a system that permits the selection of red clover plants with resistance to specific isolates of F. roseum. The first step was the evaluation of pathogenicity and/or virulence of isolates of Fusarium against individual, intact roots of red clover grown in a slant-board, nutrient-solution system. Three highly virulent isolates of F. roseum var. 'Accuminatum' were selected for use in host-plant resistance selection. Selection of plants resistant to all three isolates was made by sequentially inoculating severed taproots of 4-month-old, potted plants in the greenhouse. Plants with rotted roots in any of the inoculations were discarded. Approximately 0.6% of plants from nine commercial cultivars and 1.2% of plants from field-persistent lines were classified as resistant. Cultivars did not differ in resistance to F. roseum. This is the first attempt to select red clover with resistance to specific Fusaria.

SECTION IV. GROWTH, PHYSIOLOGY, AND CLIMATIC EFFECTS

Title: Effects of Genotypes and Environments on Growth and Feeding Quality of Forages

Leader: W. A. Kendall (U.S. Regional Pasture Research Laboratory)

Studies of the characterization of root systems of forage species grown on slant boards was continued. The design of the slant-board covers was modified to direct the nutrient solution through the absorbent material before reaching the roots. This reduces dislodging of fungi and insects during watering and has enhanced our studies with the clover-root curculio. A methodology study was made to develop a technique for identifying genotypes of legumes most efficient in root production when grown with limited mineral supplies in gravel culture. Plants from ten legume seed lots were grown in each of five dilutions of Hoagland's nutrient solution in gravel cultures. The greatest differences in plant size between and within seed lots occurred at the lowest mineral-supply treatments. The technique appeared to be useful for screening plant genotypes and for identifying plant characteristics associated with production under conditions of limited mineral supply.

Title: Improving Biological Nitrogen Fixation in Forage Legumes and Grasses

Leaders: L. D. Owens, C. Sloger, and L. D. Kuykendall (Beltsville Agricultural Research Center)

A field experiment was conducted with corn, sorghum, and pearl millet fertilized with three rates of N and inoculated with live or killed Spirillum bacteria. Dry matter production and total N in plants was significantly increased by fertilizer N but not influenced by bacterial inoculation. The number of Spirillum bacteria found on roots was low. Corn and pearl millet were grown in field-placed cylinders of ¹⁵N-labeled soil inoculated with live or killed Spirillum. No difference in dry-matter yield was observed among treatments.

Title: Alfalfa Physiology and Growth

Leaders: N. J. Chatterton and G. E. Carlson (Beltsville Agricultural Research Center)

Our efforts continue to be focused on identifying specific rate limiting factors in plant photosynthesis and yield. Genotypic variability was found for N and P uptake and/or metabolism in alfalfa. The differences in carbohydrate, N, and P components between high and low yielding genotypes

facilitate a characterization necessary for selection of improved genotypes. Individual plants of a given alfalfa genotype express a range of photosynthetic rates because of an inherent plasticity. Therefore, to characterize a genotype's photosynthetic potential, it is necessary to measure multiple plants of each genotype. We have developed two populations of alfalfa that differ in photosynthetic rates. Although no correlation was found in the unselected population between photosynthetic rate and leaflet area, a negative correlation was found in the populations selected for high and low photosynthetic rate. Therefore, to effect an increase in yield by selecting for high photosynthetic rates, leaf number must also be increased to offset the loss in area per leaflet.

Title: Dehydrogenase Levels in Cold-Tolerant and Cold-Sensitive Alfalfa

Leaders: M. Krasnuk (The Pennsylvania State University), G. A. Jung (U.S. Regional Pasture Research Laboratory), and F. H. Witham (The Pennsylvania State University)

Cold-tolerant Vernal and cold-sensitive Sonora alfalfa (*Medicago sativa* L.) plants were grown for 66 days under simulated summer (nonhardening) and winter (hardening) conditions and were assayed for the levels of cold tolerance developed at three freezing temperatures (-6, -8, and -10 C). To determine quantitative and/or qualitative differences in dehydrogenases, soluble proteins were separated from extracts of crown and root tissues by polyacrylamide disc gel electrophoresis. Localization of dehydrogenases on gels and densitometric scanning of zymograms indicated that activities of glutamate, lactate, isocitrate, glucose-6-phosphate, 6-phosphogluconate, NAD-malate, and NADP-malate dehydrogenases were high in both cultivars exposed to hardening conditions and were generally highest in Vernal. Percent increases for winter over summer levels of glutamate, lactate, glucose-6-phosphate and 6-phosphogluconate dehydrogenases were very large compared with those of isocitrate, NAD-malate, and NADP-malate dehydrogenases. Moreover, the magnitude of change in enzyme activity between summer and winter plants also was influenced by extractant (distilled water, pH 7 or 0.10 M tris-HCl, pH 7) and varied quantitatively according to the solubility of the dehydrogenases in the two extractants. Enzyme solubility differences related to cultivar or environmental influences and cold tolerance were also observed, especially for isocitrate dehydrogenase. Large quantitative differences in glucose-6-phosphate and lactate dehydrogenase activities and substantial increases in isocitrate and 6-phosphogluconate dehydrogenases localized within the 7 and 8 gel column regions of zymograms developed from winter samples implied a close relationship of these enzymes to cold tolerance. Forms of lactate, glucose-6-phosphate, and isocitrate dehydrogenases were present in hardened tissues that were not present in unhardened tissues.

It is concluded that the observed differences in dehydrogenases between hardened and nonhardened plants are major indicators of the cold tolerant state. On the basis of these and past studies, the reactions analyzed by representative hydrolytic and dehydrogenase enzymes may serve as a working hypothesis for future studies concerning the mechanics of induction and the suspected catenary nature of the hardening process.

Title: Magnesium, Ca, and K Concentration in Temperate-Origin Forage Species as Affected by Temperature and Mg Fertilization

Leaders: C. F. Gross and G. A. Jung (U.S. Regional Pasture Research Laboratory)

Under cool temperatures, in both spring and autumn, and with added Mg, cultivars having high Mg levels were Timfor timothy, Nordstern orchard-grass, and Viking birdsfoot trefoil. Species and cultivar rankings were similar for spring and autumn, but Mg concentration was greater in autumn, indicating that cool temperatures, per se may be less limiting to Mg accumulation than previously thought.

Marked differences, 5- to 7-fold, in Mg concentration occurred between species and cultivars of both grass and legumes in response to Mg fertilizer. Low $K/(Ca + Mg)$ ratios were obtained when the grasses were harvested under cool autumn temperatures. Yields were unaffected by Mg fertilization.

Forage species and cultivars with inherently high Mg concentrations at any given level of soil Mg, particularly under cool spring and autumn temperatures, may be used advantageously for controlling grass tetany. The large differences in mineral levels found between cultivars; the indication that Mg accumulation and the response to Mg fertilization were related; and the consistency of cultivar ranking over a wide temperature range, suggest that cultivar selection for Mg accumulation would be rewarding.

Title: Studies on Biochemistry of Plant Pathogenesis

Leader: D. L. Gustine (U.S. Regional Pasture Research Laboratory)

The phytoalexin medicarpin is produced by alfalfa and several other forage crops in response to disease and may be important in plant resistance to disease. Alfalfa callus tissue cultures also produce medicarpin and thus can be used to study medicarpin biosynthesis. Callus tissue cultures and intact plants were established from single seedlings so that medicarpin production in a culture can be related both to medicarpin production and disease resistance in the corresponding plant.

Previous studies designed to identify inhibitors of medicarpin synthesis in alfalfa callus tissue were continued, with improved incubation procedures being developed. None of seven protein-synthesis inhibitors tested affected medicarpin synthesis. Medicarpin synthesis was reduced by penicillin, several inhibitors of DNA and RNA synthesis, two inhibitors of mitochondrial function, and methotrexate, an inhibitor of one-carbon metabolism.

SECTION V. WEED INVESTIGATIONS

Title: Use of Herbicides in Forage Crop Management

Leaders: R. A. Peters and W. M. Dest (University of Connecticut)

Several herbicides were applied April 15 for quackgrass (Agropyron repens (L.) Beauv.) control in established alfalfa when the alfalfa was 4-5 cm tall. Significant control of quackgrass was obtained from pronamide--2.2 kg/ha, metribuzin--1.6 kg/ha, and VEL 5026--1.1 and 2.2 kg/ha. Metribuzin and the high rate of VEL 5026 caused injury to alfalfa topgrowth. This was reflected in yields only with the VEL 5026. Diuron at 1.6 and simazine at .8 kg/ha had no effect. Glyphosate (W-(phosphonomethyl)glycine), atrazine (2-chloro-4-ethylamino)-6(isopropylamino)-s-triazine), simazine (2-chloro-4,6-bis(ethylamino)-s-triazine), and paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) were applied to quackgrass in November 1975 and in April and May 1976. Silage corn (Zea mays L. var. XL 315A) was planted on both no-tillage plots and plots plowed after treatment. In general, the most effective quackgrass topkill from glyphosate was obtained from May applications when the grass was 1½ to 2 feet tall. The atrazine treatments, alone or with paraquat, were most effective, however, if applied in November or April, before rapid growth occurred. Quackgrass control, with few exceptions, was good on treated plots subsequently plowed. Rhizome samples removed in November 1976 from the May-treated plots indicated little difference in weight but a significant difference in regrowth potential with only 10% of buds sprouting in the glyphosate plots compared to 40% in the atrazine plots. Corn yields were greater in the plowed than in the no-tillage plots following all three dates of treatment. This was related in part to decreased stands in the no-tillage plots and in Stage A and B to greater competition from crabgrass.

Title: Annual and Perennial Weed Control in Corn and Forages

Leader: N. L. Hartwig (The Pennsylvania State University)

Fall panicum (Panicum dicotomiflorum) control with phenmedipham at 1.68 and 2.24 kg ai/ha has been very good in no-tillage corn. However, applications at planting time have caused excessive corn stand losses with resulting yield reductions. By applying phenmedipham at least 2 weeks and up to 6 weeks in advance of planting, corn stand reductions were minimal with nonsignificant yield reductions. Phenmedipham should be used in combination with atrazine or simazine to obtain control of a broader spectrum of weeds.

Control of alfalfa (Medicago sativa), timothy (Phleum pratense), orchardgrass (Dactylis glomerata), and associated weeds such as rough fleabane (Erigeron strigosus), dandelion (Taraxacum officinale), and quackgrass (Agropyron repens) is very difficult with a single herbicide treatment when

rotating to no-tillage corn. A tank mixture of atrazine 1.68 kg/ha + simazine 1.68 kg/ha for residual control of the perennial grasses and annual weeds with 2,4-D .37 kg/ha + dicamba .19 kg/ha for control of alfalfa and broadleaved weeds with an emulsifiable oil 2.34 l/ha to increase the foliar activity of all the herbicides gave effective control of the above weeds. Application was made when there was about 30 cm of new growth in the spring. Corn yields were 13,304 kg/ha with this treatment.

Competition from crownvetch (Coronilla varia), when used as a living mulch for no-tillage corn (Zea mays), reduced growth of yellow nutsedge (Cyperus esculentus). Herbicide mixtures of atrazine + simazine or cyanazine suppressed crownvetch sufficiently to allow corn to become established and produce corn yields of 7984 kg/ha and 7119 kg/ha respectively. Yellow nutsedge control was 97 to 98% with a crownvetch cover and 87 to 88% without it.

Title: Weed Control in Pastures and Forage Crops

Leaders: D. L. Linscott and R. D. Hagin (Cornell University)

Laboratory studies relating to problems of establishing legumes by no-tillage means suggest that products of decaying vegetation may affect alfalfa emergence and development. Under saturated soil conditions at temperatures of 5, 15, 25, and 30° C, products formed from breakdown of killed Agropyron leaves and rhizomes affected alfalfa germination and early development. Early in the decay process, leaves produced more toxins, later the rhizomes did. Some interactions between herbicide used and toxin formation was suggested by the data. Birdsfoot trefoil establishment by no-tillage planting, after treatment of sods with herbicides prior to planting, was highly successful at all locations tested in New York in 1977. Glyphosate was more effective than paraquat in controlling weeds and grass in orchardgrass, timothy, ryegrass, and bluegrass sods. Paraquat was more effective than glyphosate or dalapon in controlling tall fescue prior to planting birdsfoot trefoil. This finding was verified in controlled environments at high, intermediate, and low soil-moisture regimes. Paraquat was most effective when soil moisture was at field capacity and above. Alfalfa, red clover, and birdsfoot trefoil established successfully in corn stubble after spray treatments with glyphosate and planting by no-tillage means. Weed-control systems in rotations including corn, oats, wheat and alfalfa, planted by no-tillage and conventional means, and a mix of the two, were successful in 1977.

Title: Herbicide Residues in and on Forages

Leaders: D. L. Linscott, R. D. Hagin, and R. F. Lucey (Cornell University)

Efficacy, phytotoxicity, and residue data have been gathered for 2,4-DB on forage grasses and chloropropham (CIPC) on birdsfoot trefoil. 2,4-DB amine salts at 1.7 and 3.4 kg/ha/ai and ester formulations at 1.1 and 2.2 kg/ha/ai were compared. CIPC was tested at 3.4 and 6.7 kg/ha/ai.

Ester formulations of 2,4-DB at 1.1 kg/ha gave significantly better control of broadleaved weeds than did amine salts at either 1.7 or 3.4 kg/ha. Total residues were less than 1.0 ppm 2,4-DB equivalent for esters at 1.1 kg/ha or amines at 1.7 kg/ha, 60 days after application. Rhodia Analytical Method 115 for 2,4-DB and metabolites was modified to allow a complete analysis by gas chromatography, reducing analytical time by one-half.

In the CIPC study, annual grasses, timothy, and chickweed were reduced significantly with a consequent increase in birdsfoot trefoil yield. Residue levels of CIPC and major metabolites were below 0.025 ppm fresh weight both initially and 40 days later, at the 3.4 kg/ha rate. At the 6.7 kg/ha rate residues decreased from an initial level of 0.2 ppm to 0.03 ppm fresh weight, 40 days later.

SECTION VI. MANAGEMENT AND PRODUCTION RESEARCH

Title: Field Evaluation of Some Nitrogen Materials Used for
Topdressing Field Corn Grown for Silage

Leader: W. W. Washko (University of Connecticut)

Although losses of nitrogen from nonincorporated applications of urea to soils are known to occur, their quantification in the Northeast under crop production has not been done. This study, conducted from 1975 through 1977, was designed to obtain yield data on corn grown for silage and grain as an indirect measure of such nitrogen losses. Comparisons of urea, ammonium nitrate, solution nitrogen (Nitan), and, in one experiment, sulfur-coated urea were made with nitrogen materials applied incorporated and nonincorporated at times that would permit losses to occur. Related studies were also conducted to compare the foliar injury and subsequent yields when these materials were applied as topdressings.

The yield responses were similar for all materials, suggesting that losses are insignificant or, if they occur, are similar with all materials tested. Foliar injury and subsequent yields from topdressing materials were insignificant for urea, moderately severe for ammonium nitrate, and severe for Nitan solution. Silage yield depressions from this injury, when compared to prilled urea treatment, were 12% for prilled ammonium nitrate and 16% for Nitan solution. Similarly, grain-yield depressions were, respectively, 13% and 18%. The results suggest that further studies should be done, particularly in the areas of cultivation and at application rates which would provide greater yield responses to added increments of N.

Title: Establishment (Without Using Herbicides) of Perennial Legumes in a Permanent Grass Sod

Leaders: D. W. Allinson and R. W. Taylor (University of Connecticut)

The study was conducted to determine if mowing frequency after seeding would affect establishment of several legumes. Also, the study investigated the desirability of planting alternate rows of the legume and perennial ryegrass (Lolium perenne L.).

The experiments, each a randomized complete block design, were conducted on a soil with pH 6.4 and a soil with pH 5.6. Viking birdsfoot trefoil (Lotus corniculatus L.), Pennscoth red clover (Trifolium pratense L.), and Chemung crownvetch (Coronilla varia L.) were seeded either alone or in alternate rows with Lynn perennial ryegrass. All plots were closely mowed and raked clean prior to seeding by minimum tillage with a 'Zip' seeder. After seeding, plots were either mowed every 2 weeks or every 4 weeks for the first 8 weeks.

One midsummer harvest was taken. There was no significant difference between treatments. Red clover did yield more than birdsfoot trefoil by nearly 0.5 mt/ha. Crownvetch failed to establish in the seeding year. Yields on the pH 5.6 soil were from 0.5 to 0.7 mt/ha less than yields on the pH 6.4 soil. On the soil with low pH, stand ratings (1-10) for birdsfoot trefoil and red clover ranged from 7.5 to 8.0 and 8.1 to 9.1, respectively. For birdsfoot trefoil and red clover on the higher pH soil, stand ratings were 7.9 to 8.6 and 6.7 to 8.2, respectively.

Title: Minimum Tillage Establishment of Perennial Legumes in Four Grass Swards

Leaders: D. W. Allinson, R. W. Taylor, and A. Lillquist (University of Connecticut)

This experiment was conducted to determine (1) the influence of different grass swards on the establishment of three legume species, (2) the ability of the three legumes to establish using minimum tillage, and (3) the feasibility of establishing legumes without the aid of herbicides. Minimum tillage planting of legumes may offer a means of improving marginal pastures when conventional tillage cannot be considered because of slope or prohibitive costs.

The experiment consisted of three replications of a split-block design. Alfalfa (Medicago sativa L.), Viking and Empire birdsfoot trefoil (Lotus corniculatus L.), and crownvetch (Coronilla varia L.) were seeded, using minimum tillage, into four established grass swards. The grass swards were orchardgrass (Dactylis glomerata L.), tall fescue (Festuca arundinacea Schreb.), brome grass (Bromus inermis Leyss.), and timothy (Phleum pratense L.). Competition from the grass was minimized by close mowing prior to planting. No herbicides were used.

Birdsfoot trefoil established more rapidly than alfalfa and yielded more in the establishment year. Crownvetch failed to establish initially and only began to establish by the third year. Viking birdsfoot trefoil continued to yield more than alfalfa and Empire birdsfoot trefoil in the second year. However, by the third year alfalfa was superior to birdsfoot trefoil under the 3-cut management system employed.

Brome grass and timothy offered the least competition to the legumes. Orchardgrass severely slowed the establishment of the legumes, possibly because of its rapid leaf expansion following a harvest. Tall fescue was intermediate in its ability to restrict legume establishment.

By the third year, brome grass, timothy, and orchardgrass stands were observed to have thinned to some degree. Alfalfa in the plots where such thinning had occurred suffered a moderate amount of heaving in the third winter. Alfalfa in the tall fescue plots, which remained as a solid sward, suffered very little heaving.

Title: Handling and Utilizing Animal and Human Wastes in the Soil-Plant System

Leaders: R. W. Wengel and G. F. Griffin (University of Connecticut)

Corn silage was grown on replicated plots treated with 0, 6.5, 14.6, 29.1, 43.7, and 58.2 mt/ha sewage sludge (D.M., lime, vacuum filtered). All plots were treated in 1976. In 1977, half the plots received the sludge at rates given. The remaining half were termed 'residual' plots to study the carry-over effect from 1976 applications. The sewage sludge is considered "high quality" from the standpoint of relatively low heavy-metal content. Yields of 30% D.M. silage were 27, 48, 61, 64, 61, and 62 mt/ha for sludged plots in 1977 and 27, 34, 43, 51, 58, and 51 mt/ha for residual plots in 1977, respectively, with increasing sludge application rate. Concentrations of Cu in whole-plant tissue increased slightly with increasing sludge rates both on freshly applied and residual sludge treatments. Zn concentrations increased from 17 ppm to 23 ppm with increasing sludge rates of freshly applied sludge but decreased from 23 ppm to 16 ppm on residual plots with increasing residual sludge levels.

Soil pH of both sets of plots increased with increasing sludge rates, but the lack of a fresh supply of Zn from sludge in 1977 on the residual plots appears to have allowed a pH effect on Zn availability, whereby Zn is less available in the higher pH soil. Cd, Ri, and Pb were not detectable in the corn tissue but were extractable from soil samples with 0.1 N HCl.

Title: Producing Dried, Immature Forages as Grain Substitutes for Ruminants

Leader: R. F. Stafford (University of Maine)

Small-plot, harvest-schedule studies were initiated with pure stands of alfalfa and timothy which were established in 1976.

The alfalfa study was managed to produce immature forage (early bud stage) at different periods of the season (early June, mid-July, late August). Mature harvests (mid to full bloom) were utilized to restore plant vigor following each immature forage harvest. The timothy study was similarly planned to produce immature forage (late jointing stage) at different times from June to September.

The immature harvests produced 1013 to 2908 kg dm/ha. The immature alfalfa ranged from 20 to 26% crude protein (dm basis), and the timothy from 18 to 21% protein. Dried samples of these forages were stored for subsequent studies by the animal nutritionist.

Large plots of pure immature alfalfa and timothy were produced for pellet-ing studies conducted by the agricultural engineer. Samples of these were stored for subsequent feeding studies by the animal nutritionist, comparing the pelleted versus the chopped forage.

Title: Influence of Winter Cover Crops, Tillage Practices, and Fertilization on Silage-Corn Yields

Leader: Roy L. Flannery (Rutgers University)

An experiment was established on a Freehold sandy loam soil at the Soils and Crops Research Center at Adelphia, N.J., in fall 1975 with the following objectives in mind: to determine (1) optimum nitrogen and potassium fertilization requirements for growing silage corn on a sandy loam soil following a winter cover crop of hairy vetch and rye under conventional and no-till tillage systems; (2) relative contributions of the two cover crops toward supplying total nitrogen needs of the corn crop grown under the two tillage systems; (3) economics of using a winter hairy vetch cover crop for supplying nitrogen needs of a silage corn crop; (4) influence of these cultural practices on nutrient content (N, P, K, Ca, and Mg) of the corn ear leaf at tasseling time and the composition of the silage at harvest time; and (5) influence of these cultural practices on soil-test levels over time.

A winter cover crop of hairy vetch, with a good potential for biologically fixing atmospheric nitrogen, was successfully grown as a winter cover crop in central New Jersey in 1976 and 1977. Some slight loss of stand occurred in the no-tillage plots during the severe winter of 1976-1977. Vetch seeded on the conventionally tilled plots came through the winter in good condition and made excellent spring growth in both years.

Silage corn yields following a winter hairy vetch cover crop without applied fertilizer nitrogen were approximately equal to those following a winter rye cover crop that received 120 pounds per acre of added fertilizer nitrogen, when grown under a conventional tillage system over the two cropping seasons.

Silage corn yields following a winter hairy vetch cover crop without added fertilizer nitrogen were equal to those following a winter rye cover crop that received 180 pounds per acre of added nitrogen, when grown under a no-tillage system.

Silage corn yields were generally higher in the conventionally tilled plots, where a rye cover crop was used, than in the no-tilled plots. However, where high rates of nitrogen (186 pounds per acre) were used, the no-till plots yielded as well as, or slightly better than, the conventionally tilled plots.

The most economical cultural system employed in this study was a winter vetch cover crop with the no-tillage system where no N and 180 pounds of K₂O per acre was applied in 1976. This combination of treatments returned a net profit of \$266 per acre. The most economical combination of treatments in 1977 was the no-tillage rye that received 180 pounds per acre of N and K₂O, respectively. This combination of treatments returned a net profit of \$327 per acre.

Results obtained from this study to date indicate that a winter hairy vetch cover crop can be successfully grown and is an economically feasible source of biologically fixed N for the production of silage corn in this area.

Title: Effect of Glyphosate on Minimum-Tillage Establishment of Birdsfoot Trefoil

Leaders: D. W. Allinson, R. W. Taylor, and A. Lillquist (University of Connecticut)

An experiment was initiated to determine effectiveness of glyphosate in aiding establishment of two varieties of birdsfoot trefoil. The experiment consisted of six replications of a randomized complete block design. Using minimum tillage, Viking and Empire birdsfoot trefoil (*Lotus corniculatus* L.) were planted in plots either sprayed with glyphosate at the rate of 1.68 kg/ha or mowed and raked clean prior to seeding.

In the establishment year, plots receiving glyphosate gave significantly lower yields than plots that were only mowed. Viking and Empire, on plots which did not receive glyphosate, yielded 2.14 and 2.12 mt/ha, respectively. Viking yielded slightly more than Empire only when glyphosate had been applied (1.09 vs. 0.83 mt/ha, respectively).

In the first post-establishment year, total yields of Viking without glyphosate, Empire without glyphosate, and Viking with glyphosate (8.31, 8.07, and 7.97 mt/ha, respectively) were significantly greater than Empire with glyphosate (5.58 mt/ha).

Title: Big Packages as an Alternative Method of Handling Hay

Leaders: G. D. Wells, J. G. Welch, and J. Beaudry (University of Vermont)

A conventional square baler and a big round baler were operated side by side on adjacent windrows of the same size at approximately the same time. Total field losses as % of harvest were less than 6% for alfalfa and 2% for grass hay. Differences between machines were insignificant. Storage losses for the 1976-77 season (grass hay) were compared using lignin to NDS (neutral detergent soluble) ratios, a measure of nutrient loss. Initial values were 1:5.71. Square bales, with density 0.16 g/cc and moisture content 22% w.b. at harvest, came out of 270 days storage at 1:4.76. Round bales, density 0.23 g/cc and moisture 24%, stored under cover, came out at 1:4.16. The interior portions (surface 15 cm excluded) of round bales stored outside had the same ratio. The surface 15 cm layer of hay exposed to the weather and ground went as low as 1:1.66 on the sides, 1:2.86 on the top, and 1:3.57 on the bottom. Bales set on pallets 15 cm above ground lost no more nutrient value than the bale interiors. All ratios were approached after 120 days and changed little during the next 150 days of winter storage. About half of the rainfall from an individual storm is absorbed within the bale. Drying occurs between storms, but seldom is the period long enough in Vermont for bales to completely dry out. There is always a saturated layer near the surface.

Title: Correlation of Boron Fertilizer Applications with Yield of an Orchardgrass-Ladino Clover Mixture, Boron Soil Test Levels, and Concentration of Forage Produced

Leader: Roy L. Flannery (Rutgers University)

Work was initiated in late summer 1977 to determine (1) whether boron fertilizer applications would improve forage yields of a mixture of orchardgrass-ladino clover seeded in a no-till system with various liming and fertilization practices, (2) whether there is a relationship between relatively low rates of boron fertilization and residual soil-boron levels as measured by soil tests, (3) if there is a relationship between boron fertilization and the boron uptake of an orchardgrass-ladino clover forage crop, (4) whether critical soil test and/or tissue test levels of boron can be established for preparing boron recommendation guides for boron fertilization of orchardgrass-ladino clover mixtures on Coastal Plain soils, and (5) the economics of applying boron fertilizer on Coastal Plain soils for the production of orchardgrass-ladino clover mixtures.

Title: Evaluation of Permanent Pastures for Species Composition, Yield, Ground Cover, Grazing Pressure, and Other Management Practices

Leaders: B. S. Baker and R. L. Nestor (West Virginia University)

A 3-year study on species composition, available forage, ground cover, and management of permanent pastures was completed. Kentucky bluegrass (Poa pratensis L.) and meadow fescue (Festuca elatior L.) were found in over 90% of the surveyed pastures during both summer and fall from 1975 through 1977. Red top (Agrostis alba L.), timothy (Phleum pratense L.), and white clover (Trifolium repens L.) were found in over 90% of the pastures in summer but were not as common in late fall. Orchardgrass (Dactylis glomerata L.), along with the five other species mentioned above, was by far the most common species found. The two most common weeds were buckhorn plantain (Plantago lanceolata L.) and wild carrot (Daucus carota L.), being present in 75% of the pastures. More forage was always available for grazing animals in the summer than in late fall. Less than 425 kg/ha of forage was available in either summer or fall during 1976 and 1977; whereas 1200 and 700 kg/ha were available in summer and fall of 1975 on the same pastures. Ground cover was closely related to available forage and fertility.

Title: Establishment and Management of Several Grass and Other Species for Forage and Ground Cover

Leader: W. C. Stringer (The Pennsylvania State University)

Blackwell switchgrass (Panicum virgatum) plots were seeded on various dates during the spring-early summer period of 1976 with a Brillion cultipacker seeder and a grain drill with packer wheels equipped for sod seeding. Switchgrass stands seeded with the grain drill throughout the 1976 season

tended to be superior to those seeded with the cultipacker seeder, as indicated by yields of seeded species taken in July 1976. Seedings in May and July established better than June seedings. Seedings made in April failed completely.

Red clover (Trifolium pratense) cv. Kenstar seeded in April 1976 was attacked by northern anthracnose in spring 1977 at State College. The previously vigorous stand was severely weakened and invaded by annual grassy weeds. Total yields for 1977 were 8.4 mt/ha with only 1.34 mt/ha produced from mid-July until late August.

Established flatpea (Lathyrus latifolius) yielded 8.9 mt/ha when harvested on July 26, 1977, in the green-seed stage, but regrowth was so poor that weeds invaded and no further harvests were made.

Title: Evaluation of Small Grain and Forage Crop Varieties and Production Techniques and Methods for Use in New Jersey

Leaders: J. R. Justin and J. P. Zublena (Rutgers University)

A forage variety trial, including alfalfas, red clovers, tall fescue, orchardgrasses, bluegrasses, perennial ryegrasses, brome-grasses, and timothys, was established at the Soils and Crops Research Center, Adelphia, New Jersey, in fall 1977. Forage yields will be determined along with adaptation and other varietal characteristics for making variety recommendations in the State of New Jersey.

Title: Adaptability of Forage Legumes

Leader: M. A. Sprague (Rutgers University)

Second-year yields of ten alfalfas showed all varieties to be similar, with Titan, WL-305, and Vernal slightly higher in yield than others tested. Autanga and Talladega crimson clover and Nangeela and Woogenellup sub-clovers were superior in yield to others tested. It was reassuring that these, plus Yuchi arrowleaf clover, exhibited good winter survival.

Three varieties of subclover, five of crimson, and five of red clover were sown late in August 1977 for further comparisons. Emergence and fall seedling growth were excellent.

Title: Nutrient Utilization Efficiency of Crop Species, Hybrids, and Cultivars

Leader: R. H. Fox (The Pennsylvania State University)

Twenty-three cultivars of seven warm-season grass species (little, big, old world, and caucasian bluestem; indiangrass; switchgrass; and deertongue) and three cool-season grasses (orchardgrass, timothy, tall fescue) and Lathco flatpea were planted in 2-meter rows in 1976 in a replicated trial in soil which was very low in available P (5 ppm Bray 1), with and without P fertilizer. A blanket application of N, K, and lime was applied to both treatments. Eighteen of these 27 cultivars were well enough established in 1977 that yield, P uptake, and IVDMD measurements could be made.

The grasses were harvested at the early heading stage and at the end of the growing season in October. This resulted in three harvests for the cool-season grasses and deertongue grass and two harvests for the warm-season species. A 0.3 x 1.0 m section was harvested from the center of the rows. Cutting height for the cool-season species and deertongue was 5 cm above the ground; for the warm-season species it was 20 cm.

The highest yielding grass in the low-available-P soil was caucasian bluestem, with a total yield of 561 g dry matter per 1-m row. The next highest were tall fescue, orchardgrass, and Kentucky 729 switchgrass, with total yields of approximately 425 g/row. The highest yielding cultivars in the high-available-P soil were Ky 729 switchgrass, caucasian bluestem, Lathco flatpea, and orchardgrass, with yields of 676, 659, 618, and 541 g/row, respectively.

P concentration in the grasses grown on low-available-P soil was low in all cultivars (0.11 to 0.14%). Lathco flatpea had the highest P concentration (0.18%) but its yield was relatively low (306 g/row) under the low-P regime. Consequently, except for flatpea, P contents of the plants in the low-P soil were strictly a reflection of their dry matter yields. P concentration in the P-fertilized forages ranged from 0.20 to 0.27%.

The IVDMD of the warm-season cultivars ranged from 42 to 57% in the low-available-P soil, with most in the 43 to 51% range. The IVDMD in the cool-season grasses was 64 or 65% in the low-available-P soil. IVDMD values of plants in the high-available-P soil were approximately the same as for those from soil not fertilized with P, except for caucasian bluestem which showed an increase from 52 to 62% with P fertilization.

The results of these data for 1 year indicate that, of the cultivars tested, those that will produce the highest digestible dry matter yield in a low-available-P soil with a pH above 6.0 are caucasian bluestem, tall fescue, and orchardgrass (270-290 g/row). The little bluestems performed quite poorly in the soil and environmental conditions of the experiment, producing only 60 to 80 g digestible dry matter/row. The big bluestems produced 125 to 170 g, the switchgrasses 125 to 190 g, and the one indiangrass that survived, 175 g digestible dry matter/row.

Title: Production, Mineral Content, IVDMD, and Acceptability to Cattle and Sheep of Some Foreign Varieties of Forage Turnips, Swedes, and Beets

Leaders: V. Ulrich (West Virginia University) and G. A. Jung (U.S. Regional Pasture Research Laboratory)

Fodder varieties of turnips, swedes, and beets were established in 1977. Nitrogen fertilizer was applied at 67 kg/ha. Potassium and phosphorus were present at high levels. For weed control, Eptam was applied at levels recommended on the label for other crops. This, along with an early drought, appeared to delay germination, but provided satisfactory weed control. Other herbicides will be tested in 1978. Turnips and swedes, with the exception of one variety, were exceptionally susceptible to root-worm damage. All were susceptible to aphid damage. The fodder beets did not manifest these susceptibilities. The range of dry matter yields (t/ha) were: turnips, 1.97 to 10.36; swedes, 1.52 to 7.73; beets, 7.30 to 11.19.

The mineral concentrations of swedes, turnips, and beets revealed that P, K, Ca, Mg, Cu, B, Al, and Zn were approximately within the same mineral range as the contents of the more common forage grasses and legumes. However, the leaves of beets were high in K ($\bar{X}$ = 4.46%), Mn ($\bar{X}$ = 184.4 $\mu\text{g/g}$), and Na ($\bar{X}$ = 3255.4 $\mu\text{g/g}$). The mean percentage crude protein content for the various species when harvested in November were: turnips, leaves--19.61, roots--10.37; swedes, leaves--22.86, roots--9.29; beets, leaves--17.1, roots--6.71. The IVDMD for turnips and beets are respectively: leaves 79.49, roots 82.05; leaves 80.69, roots 82.78.

Title: Productivity and Quality of Fertilized Perennial Forages

Leader: L. E. Lanyon (The Pennsylvania State University)

Swards of crownvetch with either orchardgrass, brome grass, tall fescue, or timothy, and swards of the grasses alone grown on a Hagerstown silt loam soil in Centre County, Pa., were harvested one time this year. The spring fertilizer applications were made in 1977 and the last manure application was in 1976.

Yields of the mixed swards were generally increased by P and/or K when increased from 49 and 93 kg/ha to 98 and 186 kg/ha, respectively. The only significant response was for the brome grass association. There was some response to spring applied N (56 kg/ha). Yields tended to be greater where 56 kg/ha N had also been applied after the first harvest during 1976. Application of N decreased the crownvetch percentage in the swards.

Grass swards generally responded to spring applied N at rates of up to 112 kg/ha N. The response was favorably influenced by additional N applied after the first harvest in 1976.

The response of mixed and grass swards to the carryover effects of the 1976 manure applications tended to be negative at low rates (112 kg/ha N) and positive at higher rates (199 kg/ha N) as compared to 0 kg/ha N. The responses were negative when compared to 56 kg/ha N applied in the spring.

These general trends agree with those of preceding years. Due to weed infestation and changing botanical composition of the swards, this experiment was discontinued in 1977.

Title: Integration and Evaluation of Forage Production, Handling, and Utilization Systems

Leaders: D. P. Knievel, E. J. Partenheimer, and W. L. Kjelgaard (The Pennsylvania State University)

A forage-dairy systems model utilizing linear programming and dynamic simulation techniques is under development. The system begins with land as a resource base, incorporates crop establishment, production, harvesting and storage subsystems, and concludes with a dairy enterprise subsystem. Biological and economic parameters are considered. Dynamic simulation techniques are used to develop quantitative subsystem data. Linear programming methods are used to evaluate the participant subsystems.

A working version of the overall systems model is expected shortly. Crop production simulation models developed with Project NE-48 are used to estimate corn and silage production. Labor and energy needs and dry matter losses for forage harvesting, handling, storage, and feeding have been determined. Silage systems used 0.40 man-hr/metric ton fresh weight and the available energy from 3.4 liter of tractor fuel per metric ton DM, while hay systems averaged 0.76 man-hr and 2.0 liter fuel per metric ton DM. Dairy utilization and production parameters are being developed in conjunction with Project NE-108. When completed, our results will allow quantitative evaluation of the significance of improving various parts of a forage-dairy production and utilization system in the Northeast.

Title: Development of Seeding Techniques and Management Systems for Feed Crops in Southwestern Pennsylvania

Leader: W. G. Downs III (The Pennsylvania State University)

With the use of a Bettinson 3D drill, large-scale sod seedings of red clover were accomplished at the Western Pennsylvania Forage-Beef Farm. Paraquat was used to retard the growth of a deteriorated orchardgrass stand. The seedings were highly successful, but regrowth of broadleaved weeds following the seeding was excessive.

The drill was used to seed alfalfa varieties WL 219-311-318 into a corn-stubble field following a 1976 no-till corn seeding. Lime and 0-25-25 fertilizer were broadcast prior to the no-till seeding and 2, 4-D plus

paraquat was used to control existing vegetation. The seeding was highly successful, rivaling the best conventionally seeded alfalfa fields at the Southwestern Field Research Laboratory. Two cuttings of hay were harvested in the seeding year. The first cutting contained excessive amounts of corn fodder but was quite saleable.

With the use of paraquat and the Bettinson drill, successful plantings of alfalfa, red clover, and birdsfoot trefoil were made into a rye cover crop. The rye was close to heading but was easily killed by the paraquat. Two cuttings of high-quality hay were harvested in the seeding year.

Alfalfa was successfully added to a stand of birdsfoot trefoil on a soil of mixed drainage; but the use of 2, 4-D-B caused major damage to the seeding applied 3 weeks after emergence of the alfalfa.

Title: Effect of Management Factors on Alfalfa Productivity and Persistence

Leaders: A. A. Hower, Jr. (The Pennsylvania State University) and K. T. Leath (U.S. Regional Pasture Research Laboratory)

The last alfalfa harvest at this location should be scheduled for August or late September-early October.

A potassium-rates-at-seeding experiment was established in southeastern Pennsylvania (Landisville) in spring 1975, where K₂O rates of 0, 134, 269, and 403 kg/ha were applied at seeding. Two anthracnose-susceptible (Saranac and Team) and two resistant varieties were seeded. Best yields were from the Saranac AR variety. The K responses were never sharp and had disappeared by spring 1977. This work indicates that large applications of K at seeding rapidly lost their effectiveness at this location due to luxury uptake or soil fixation.

Four alfalfa varieties (WL-311, Arc, Iroquois, and Saranac AR) seeded in April 1975, were harvested at weekly intervals, starting in fall 1976. First harvest of the following spring was shown to be the measure of fall-harvest effect, with second harvest (summer) showing much smaller differences. Spring yields for first-harvest year (1976) showed no adverse effects on dry matter from fall-harvest date. Spring 1977 yields show a sharp decrease in dry matter yields in plots harvested during September, with most severe depressions for September 1 and September 8 harvests. Dandelion infestations in spring 1977 marked these plots clearly. Data are being collected on numbers and weights of crown buds and on TNC reserves. Three alfalfa varieties, Arc, Saranac AR, and Spreador (a rhizomatous cultivar), were evaluated at State College. Spreador yields were slightly lower (P.05) than Arc and Saranac AR in the third year under a three-hay-harvest management.

Title: Use of Chemical Additives in Forage Preservation

Leaders: W. L. Kjelgaard, L. L. Wilson, and H. Nehrir (The Pennsylvania State University)

A series of experiments was conducted within the past 4 years to evaluate application of organic acids and other chemicals to high-moisture hay crops. DM losses were measured for treated and untreated hays, through preparation, harvesting, storage, and feeding of rectangular bales, large round bales, and stacks.

The results of these investigations are as follows: (1) High-moisture alfalfa hay (25 to 35%) treated with organic acid 1 to 2% of wet-forage weight) was of comparable quality to heat-dried hay and showed increased DM yield/ha when compared to field-cured; (2) Field, machine, storage, and feeding DM losses were reduced when hay (28 to 32%) was treated with chemicals; (3) Chemically treated hay had less temperature rise in storage when compared with untreated hay baled at the same moisture content; (4) field-stored round bales and stacks had higher amounts of insoluble protein than indoor-stored rectangular bales; (5) No change in crude protein content was observed, but there were differences in available protein, fiber, NDF, and IVMDM; (6) Organic-acid treatment resulted in an average savings of 685 kg/ha DM; (7) Storage of high-moisture hay, whether treated or not for 6 to 7 months, resulted in losses of more than 90% of the carotene, compared to heat-dried treatment; (8) Animal acceptability and intake were higher for acid-treated hay than field-cured, regardless of package forms; (9) Addition of water to the acid reduced intensity of irritating vapors, improved safety, and did not reduce effectiveness of the chemical; and (10) With an average current total cost for acid application of \$8.40/ton of forage dry matter, and assuming a value of forage DM of \$80/ton, a reduction in forage losses in excess of 10.5% represents net benefits from using these additives.

Title: Comparison of Hay Handling Systems

Leaders: L. L. Wilson, P. C. Lootens, W. L. Kjelgaard, W. C. Stringer, and D. L. Lee (The Pennsylvania State University)

A series of trials has been completed to compare different hay harvesting and feeding systems, primarily for beef brood cows. During a 3-year period, large round bales, representing four different machines, 1-ton stacks (all stored outside) and rectangular inside-stored bales, were harvested from the same acreages of hay. In addition, corn-stalk residues, harvested with a flail-type, 1-ton stacker, were included in the comparisons. Feeding of round bales and stacks were in a 3-sided fenceline feeder on concrete, and rectangular bales were fed in a conventional hay feeder. Inside-stored rectangular bales averaged significantly higher than outside-stored packages for ADF percent, and available protein (crude protein-ADF protein). On the basis of these trials, 32% more hay land (or harvested dry matter) would be required if outside-stored large package systems were used compared to inside-stored rectangular bales. Inside-stored large hay packages would result in a similar carrying capacity. In

addition, although inside-stored rectangular bales were fed on a limited basis, and large, outside-stored hay packages fed on a free-choice basis, significantly lower animal performance levels were observed for the latter systems. Application of ammonia through the cold-flow method to cornstalks resulted in low retention of nitrogen in the cornstalk stacks, and did not result in different animal performance than non-ammonia-treated cornstalks. Generally, labor requirements were reduced by approximately 50% by the large, hay packaging system, but fuel requirements were the same for rectangular-bale and other systems. Feeding large bales beneath shed-type shelters reduce waste by approximately 10% compared to noncovered systems. Trials are in progress with growing heifers and first-calf heifers receiving different types of hay packages and varying amounts of corn-silage supplement.

Title: Open and Forested Upland Range for Beef Production

Leaders: L. L. Wilson, W. C. Stringer, T. W. Bowersox, and R. H. Fox
(The Pennsylvania State University)

This project was recently initiated to determine response and productivity of native and improved plant species on acreages with soil and site limitations, and to increase the contribution of these land types to the agriculture economy and to the many farms composed of varying portions of this type of land. Several different types of open, abandoned farm or pasture land, established hardwood stands, and young conifer and hardwood stand sites have been selected for this research. Primary efforts to this point have been to refine and define sampling schemes. In addition to information on vegetative cover and response to improvements, data on response under animal pressure and soil characteristics will be obtained.

Title: Pennsylvania's 1977 Alfalfa Production Contest

Leader: John E. Baylor (The Pennsylvania State University)

Alfalfa is Pennsylvania's most productive perennial forage crop. In 1977, for example, some 845,000 acres were harvested for hay and silage with a total estimated value approaching \$200 million.

Last year, 37 alfalfa growers in Pennsylvania completed all of the requirements in a competitive alfalfa growing program--its purpose, to measure just how much alfalfa hay, protein, and energy an acre of Pennsylvania land will produce, and at the same time develop more reliable farm data on alfalfa production costs.

Yields were measured by cuttings from the windrow of a selected 5-acre block, using a special measuring device designed for the Pennsylvania Grassland Council. Quality data included crude protein, ADF, TDN, and a complete mineral analysis. Per-acre yields of protein and TDN were calculated, as was nutrient removal for all major elements. Cost-of-production data are currently being summarized.

Pennsylvania's top grower in the 1977 program produced an estimated 8.1 tons of alfalfa-hay equivalent, 3,133 pounds of protein, and nearly 9,300 pounds of TDN per acre. Four other participants had per-acre hay-equivalent yields of 7 or more tons.

Nutrient removal for P_2O_5 was generally in line with normally established removal values--70 to 80 pounds per acre, with a top removal of 105 pounds. Removal of potash varied with yield, with total removal on some farms approaching or exceeding 500 pounds of K_2O per acre.

An entry fee of \$50 was paid by each participant, with many growers sponsored or co-sponsored by a local seedsman or fertilizer dealer. The program will be continued and expanded in 1978.

Title: Research with Brassica Crops and Fodder Beets in Pennsylvania

Leaders: G. A. Jung, R. A. Byers, and C. F. Gross (U.S. Regional Pasture Research Laboratory)

Brassica crops and fodder beets were successfully established in pastures in Centre, Westmoreland, and Greene Counties. Several factors adversely affected establishment in these studies: droughty weather, high temperatures, and certain insects such as flea beetles. Studies by Mr. Herb Reed, an Entomology graduate student, showed that low numbers (one/plant) of flea beetles reduced stands at warm temperatures, even with conventional seedbed preparation. Seeding in early April, therefore, would be preferred over a later spring planting because the weather conditions are more favorable, and insect problems may not be as serious.

Yields were generally quite good when weather conditions were not too unfavorable and soil fertility not too low. With good soil fertility, turnips yields ranged from about 7,500 to 10,200 kg/ha (3.5 to 5.0 tons/acre) and kale yields ranged from about 3,200 to 6,400 kg/ha (1.5 to 3.0 tons/acre) in 12 weeks. In the same pasture, yields were reduced 75% by insufficient nitrogen. We found that manure, if applied before or at seeding, would overcome the nitrogen deficiency. However, neither liquid manure nor commercial nitrogen fertilizer corrected the nitrogen deficiency problem if application was delayed to early June. By this time weather conditions favored the growth of weedy grasses over the Brassica species.

Dry matter digestibility of all plant parts, leaves, petioles, stems, and roots has ranged from about 70 to 95%. The crude protein of rape and kale leaves sometimes exceeded 20%. Crude protein of the root crops, turnips and swedes, as expected was much lower.

Both sheep and cattle were observed to prefer the fodder beets over the Brassica crops. But this may have only marginal importance because turnips and rape were consumed very readily too by cattle and were preferred over orchardgrass aftermath. With a relatively high stocking rate (14 head/acre) waste was insignificant. For example, with 1/3 acre of turnips, we found less than a dozen roots broke off when the animals pulled them up, and only two roots were left uneaten because manure dropped on them. The cattle did not consume orchardgrass aftermath until only rape stubble (3-6 inches) remained.

Title: Response of Alfalfa to Irrigation, Fertility, and Cutting Management

Leaders: N. A. Clark and J. H. McNemar (University of Maryland)

In the fall of 1973 an alfalfa experiment was established to measure response of alfalfa to irrigation, fertility, and cutting management. Two alfalfa cultivars were seeded: WL311, a new variety; and Williamsburg, an old variety. The irrigation treatments were nonirrigated and irrigated. There were three levels of fertility: one-half the soil-test recommendation; soil-test recommendation; and double soil-test recommendation. The four cutting managements were (1) first harvest at early-bud followed by 30-day intervals, (2) first harvest at full-bud followed by 30-day intervals, (3) first harvest at full-bud followed by 40-day intervals, and (4) first harvest at half bloom followed by 40-day intervals.

After three years, the plots were harvested twice in 1977 to see the residual effects of the treatments. All the plots were harvested in mid-May and then again 35 days later. There was no significant difference between the irrigated and nonirrigated treatments. The three fertility rates, four cutting managements, and two cultivars were significantly different at the 1% level, using Duncan's Multiple Range Test. The one-half rate of fertilizer was the lowest at 4.85 mt/ha of weed-free alfalfa followed by the soil-test rate at 5.33 mt/ha, and then double the rate, which yielded 5.77 mt/ha. Of the four cutting managements, the highest yielding was the half-bloom at 6.10 mt/ha of weed-free alfalfa, followed by the full-bud, 40-day interval at 5.80, the full-bud, 30-day interval at 5.69, and the early-bud at 3.68 mt/ha. The new variety, WL311, yielded 5.74, compared to the old variety, Williamsburg, at 4.89 mt/ha.

Title: Evaluation of Sod-Seeded Pastures using Dairy Steers and Heifers

Leaders: A. M. Decker, J. H. Vandersall, and N. A. Clark (University of Maryland)

Pastures, heavily infested with herbaceous weeds and woody species, were clipped with a heavy-duty rotary mower in 1974. The area was divided into experimental paddocks and grazing was started in 1975. Pasture treatments were: (1) Brush and weed removal plus fertilization; (2) Brush and weed removed, fertilization, and sod-seeding with alternate row seeding of crownvetch and red-ladino clover; and (3) Brush removal, fertilization, and sod-seeding with alternate row seeding of alfalfa and red-ladino clover. In 1977, 80 lbs. of nitrogen was applied to treatment one. Dairy heifers and steers were used as both testers and grazers. The put-and-take system was used to provide uniform grazing pressure.

In contrast to previous grazing seasons, sod-seeding did not increase pasture carrying capacity, daily animal gains, or gains per hectare. Most of the red clover was gone from the sod-seeded paddocks and there was not enough of the other legume species to offset the nitrogen added to the check pastures. Also, there was a good stand of winter annual hop clover and vetches in most of the check paddocks.

Title: Alfalfa Variety Trials

Leaders: N. A. Clark and J. H. McNemar (University of Maryland)

A single variety trial was harvested in 1977. This study was established in the spring of 1976 so this is the first full-season harvest year. Because of limited rainfall, yields were lower than in previous years. Forage yields ranged from 3.11 to 3.85 tons per acre. Williamsburg, a variety that has been around for many years, produced 0.65 tons more than the lowest yielding variety and only 0.09 below the highest yielding variety. It was higher than either ARC or Saranac AR.

Title: Sod-Seeding Studies Involving Species, Herbicides, and Seeding Units

Leaders: A. M. Decker, R. F. Dudley, and N. A. Clark (University of Maryland)

Red clover, ladino clover, birdsfoot trefoil, and crownvetch were sod-seeded into a bluegrass sod in the fall of 1977. Each species was seeded alone and in combination with each of the other species. When two species were sod-seeded, they were seeded in alternate rows. Each species was also seeded with and without banded P₂O₅. Fertilized and nonfertilized checks were also included.

In a second study, red clover and alfalfa were sod-seeded into a bluegrass-bromegrass pasture sod using the Zip, Bettison, and John Deere Powr-Till machines. A comparison was also made between paraquat and glyphosate for control of sod.

Data will be collected during the 1977 growing season.

Title: Improvement of Birdsfoot Trefoil Seed Production Practices

Leaders: D. L. Linscott and H. M. Schaaf (Cornell University)

Birdsfoot trefoil (*Lotus corniculatus* L.) seed production has been declining in the Champlain Valley of New York and Vermont. This study was initiated to determine the problems and to find answers, if possible. Several herbicides were evaluated. Pronamide and dalapon for grass control and simazine for both grass and broadleaf control were found to be effective. Burning of fields proved to be as effective as insecticides in controlling spittlebug, if performed early in the spring before significant plant growth. Later burning damaged plants resulted in lower seed yields. Severe reduction in seed yield resulted from the tarnished plant bug. Poor stand establishment has been found on soils low in phosphorus and pH. A positive early-growth response was shown where phosphorus was applied up to 40 kg/ha banded or 100 kg/ha broadcast at seeding. Also, poor stands and loss of stands have been linked to disease organisms in the soil. No practical disease control has been found, except long rotations out of birdsfoot trefoil.

Title: Pasture Renovation Potential of Glyphosate for Weed Control
Prior to Reseeding Desirable Species

Leader: D. L. Linscott (Cornell University)

Paraquat and glyphosate each at 0.5-, 1-, and 2-kg/ha and dalapon at 3-, 5-, and 8-kg/ha were applied to well-established sods of perennial ryegrass, timothy, bluegrass, tall fescue, and orchardgrass in May of 1976 and 1977. Within 2 days after herbicide treatment, Viking birdsfoot trefoil (10 kg/ha) was planted with a power-till drill. The site was a poorly drained Erie-Ellettsville channery silt loam (reworked) with a fragipan at 30 to 40 cm. Results were characterized by unusual effectiveness of paraquat in controlling the perennial grasses. In 1976, birdsfoot trefoil established successfully after all rates of paraquat except 1/2 kg/ha on fescue. Results were similar to 1977 except for orchardgrass at 1/2- and 1-kg/ha paraquat; birdsfoot trefoil did not establish successfully. Both years, 1- or 2-kg/ha glyphosate was required for consistent birdsfoot trefoil establishment. Fescue was more tolerant of glyphosate than the other species. An 8 kg/ha rate of dalapon was required for birdsfoot trefoil establishment, but results were not as consistent as with the other two herbicides. Tall fescue was most resistant to dalapon and bluegrass the least in this study.

SECTION VII. ENGINEERING RESEARCH

Title: Engineering Systems for Forage Crop Production and Use

Leader: W. L. Kjelgaard (The Pennsylvania State University)

The distribution of energy and labor needs in forage systems were estimated using mathematical modeling techniques.

Silage systems showed a lower labor need but higher energy use in comparison to hay systems. Horizontal silos with dump truck filling and loader and self-unloaded wagons for feeding reduced both labor and energy use by about 20% over tower silos with wagon transport and mechanical unloading and feeding. Round-bale or hay-stack systems, with outdoor storage, offered a labor reduction of about 20% in comparison to regular bales stored indoors but increased energy need by a factor of 2.

In general, silage systems from this model used 0.9 man-hr and 2 gal of fuel from harvest to feeding of 1 ton of dry matter. Similarly, hay systems averaged 1.7 man-hr and 1.2 gal of fuel per ton of dry matter. For either silage or hay systems, approximately 60 to 70% of labor input and 90% or more of the energy input per ton of DM fed was associated with field work and handling and the remainder with feeding. A reduction in dry matter losses during harvest, storage, and feeding would help to conserve both labor and fuel in forage systems.

Average labor and energy needs, from harvest to feeding, per ton of dry matter available and acceptable as feed:

System	Labor	Energy
	man-hr/ton DM	gal fuel ¹ /ton DM
Silages: Tower silos, unloaders, and feed bunk	1.00	2.10
Silages: Horizontal silos, unload wagon, and feed bunk	0.71	1.70
Regular hay bales, indoor storage, manually loaded, self-feeding rack	1.92	0.65
Round bales, outdoor storage (6 mo), mover, and fence-line feeder	1.43	1.37
Hay stacks, outdoor storage (6 mo), mover, and fence-line feeder	1.66	1.57

¹Based on 12.48 hp-hr available energy per gal of fuel.

Title: Processing Dried, Immature Forages as Grain Substitutes for Ruminants

Leader: R. J. Rowe (University of Maine)

Second-cut, immature alfalfa and timothy plots were harvested in late July. Both plots were field-dried to about 40% moisture, wet basis, in about 24 hours, followed by drying with heated air at 60° C. Samples were split, and half were ground and pelleted in preparation for feeding trials in early 1978. Samples for nutrient analysis were dried at temperatures of 60 and 140° C in chopped form, and half were ground and pelleted.

Work was continued on refining costs and harvest-loss data for input to the NE-111 effort on developing a comprehensive forage-system-analysis model.

Title: Alfalfa as Human Food

Leader: L. F. Whitney (University of Massachusetts)

Separation of chloroplasts from alfalfa juice was accomplished using a pilot-scale dialysis unit Amicon 0.2 micron filtration paper. Programmed backflushing under pressure partially restored flux rates to economically feasible levels. Flocculants (cationic, 100,000 m.w.) were used at levels of 50 pp to enhance ultrafiltration.

Filter aids with body feed in alfalfa juice were investigated using a (Büchner funnel) vacuum filter to remove chloroplasts. The method shows promise with dramatic improvement in fluxes at pH 8. Natural and high pH's (6 and 10) resulted in relatively low fluxes with corresponding drops in protein passing through the filter cake. A continuous vacuum drum (or vacuum belt) with removable filter cake is envisioned as a decolorizing unit operation without heat coagulation of protein.

Title: Yeast Cultivation on Alfalfa Process Wastes

Leader: R. E. Mudgett (University of Massachusetts)

Fermentations of alfalfa process wastes from mechanical extracts in protein recovery give biomass densities up to 19/g in submerged culture, with 65% dissolved solids reduction. The need for nitrogen, sulfur, and phosphorus supplements prior to fermentation is being investigated by elemental analysis, proximate analysis, and growth studies of the yeast *C. utilis* in flask cultures. Kinetic studies of optimal growth conditions for the organism have also been initiated.

Title: Solid-State Fermentation Processes in Plant-Protein Recovery

Leaders: R. E. Mudgett, R. Rufner, and P. Pellett (University of Massachusetts)

Investigation of solid-state fermentation processes for plant-protein recovery is continuing. The effects of oxygen and carbon dioxide in regulation of enzyme synthesis for a cellulase producing fungal strain, Aspergillus sp. QM 9994, isolated in this laboratory has been initiated and preliminary studies to establish the feasibility of solid-state fermentation processes in enhanced cell rupture completed. The nature of surface growth of fungi in a solid-state process is also being investigated by means of scanning electron microscopy. Nutritional studies of amino-acid composition in mechanical and enzymatic extracts have also been completed.

Title: Enzymatic Methods in Plant-Protein Recovery

Leaders: R. E. Mudgett and R. Rufner (University of Massachusetts)

Investigation of in vitro enzymatic methods for enhancing cell rupture on alfalfa protein recovery has been completed. The effects of cellulase, pectinase, and phospholipase have been examined by electron micrographs. Mixtures of cellulase and pectinase were found to enhance cell rupture and increase protein recoveries up to 50% greater than mechanical extraction methods.

SECTION VIII. NUTRITIVE EVALUATION AND UTILIZATION

Title: Magnesium Supplementation of Wintering Beef Cows

Leaders: R. L. Reid, Susan Morash, and E. K. Inskeep (West Virginia University)

Trials were run in three winters (1975-1977) on methods of supplementing Mg to pregnant beef cows. In the first 2 years, Mg as Epsom salts ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$) was provided in the drinking water at an average level of 14 g Mg per head per day. In the first year, large round bales (first cutting orchardgrass) were fed and Mg supplementation resulted in consistent increases in serum Mg concentration of treated cows, no differences in water consumption, and an increase in body weight (average 18 kg/head) of treated vs. untreated cows in the last 3 months of pregnancy. Responses to water treatment in the second winter were minor, presumably due to the feeding of better quality grass-legume hay containing .17% mg, compared with .12% Mg in the round bales. In the third year, 84 beef cows were fed, in sequence, corn stover, corn silage, and grass hay during the last 4 months of pregnancy and supplemented with high and low levels of Mg and P in a grain mixture (1 kg/head/day) in a 2 x 2 design. Supplementation with higher levels of Mg (.45 vs. .16% Mg in the total diet) increased serum Mg and, again, resulted in increased weight gains in pregnant cows (.46 vs. .31 kg/head/day) in late pregnancy.

Title: Alternative Management Systems for Tall Fescue and Birdsfoot Trefoil Using Grazing Ewes and Lambs

Leader: R. L. Reid (West Virginia University)

Four groups of 18 ewes with their lambs were grazed on four pasture management systems: (1) Ky-31 tall fescue fertilized with N (168 kg N/ha, in split applications), grazed rotationally; (2) Ky-31 tall fescue and Empire birdsfoot trefoil, seeded together, grazed rotationally; (3) fescue and birdsfoot, seeded separately in individual pastures, with sheep grazed between the grass and legume in two spelling systems: (a) 2 days fescue, 1 day birdsfoot, (b) 6 days fescue, 1 day birdsfoot; (4) fescue and birdsfoot, seeded separately as pure stands in the same pasture (2:1 ratio) and grazed continuously with no restriction on access. Animal numbers were adjusted as necessary to maintain a similar grazing pressure on the systems. The N-fertilized fescue carried 25-30% more animal units through the grazing season than the mixed fescue-birdsfoot pastures. Little overall change in body weight of the ewes on the four systems was noted from April-September. Live weight increases in the lambs after 40 days grazing averaged 195, 163, 209, 173, and 249 g/day on systems 1, 2, 3a, 3b, and 4, respectively. After 125 days, the average gains were 118, 104, 123, 127, and 141 g/day, respectively. Live weight gains of lambs suckling ewes on the mixed fescue-birdsfoot pastures were not better than on N-fertilized fescue, and

performance of lambs on fescue alone was markedly better than in previous trials with early weaned lambs on Ky-31 fescue. On treatment 4, sheep grazed the birdsfoot preferentially as long as the supply lasted, but the superior performance of the lambs on this treatment persisted to the end of the season.

Title: Effects of Magnesium and Sulfur on the Nutritive Quality of Forages

Leaders: R. L. Reid (West Virginia University) and G. A. Jung (U.S. Regional Pasture Research Laboratory)

Alfalfa treated with four levels (0, 112, 224, 448 kg Mg/ha) of kieserite ($\text{MgSO}_4 \cdot \text{H}_2\text{O}$) fertilizer was harvested in first and regrowth cuttings in 3 years following initial application, and fed in digestibility, intake, and mineral-balance trials to growing lambs. Fertilization markedly increased Mg concentration, with only minor effects on S concentration. At ad lib. feeding, Mg fertilization had no effect on apparent absorption (AA, %) of Mg, Ca, P, K, and N, but increased AA of S, and increased Mg retention. Level of kieserite had no effect on digestibility of the alfalfa, but intake was increased at the highest level (448 kg Mg/ha) of fertilization in the first 2 years after application, with no effect in the third year. Increase in intake over the 0 treatment averaged 8.8 and 11.7% in the first and second years, respectively, with increases in individual cuttings ranging from 3.1 to 18.9%.

In further trials to partition the effect of Mg from that of S, alfalfa, and orchardgrass were grown under four fertilizer treatments (113 and 564 kg S/ha, 436 kg Mg/ha as $\text{MgSO}_4 \cdot \text{H}_2\text{O}$, and no fertilizer). The alfalfa was harvested in three cuttings in 1976 and 1977, and orchardgrass in two cuttings in 1976. Hays were fed ad lib. in intake and mineral-balance trials to mature beef cows and wether sheep. Fertilizer treatment had no effect on dry matter digestibility (DMD) by cows or sheep. Sulfur level had no effect on intake ($\text{g/kg BW}^{.75}$), but MgSO_4 fertilization of alfalfa increased DM intake by 5% in sheep and 12.6% in cows, compared with no fertilizer, over all cuttings. The effect was not obtained with orchardgrass. DMD in all trials with sheep averaged 2 percentage units higher than for cows. Mean intake by sheep was 83.9 vs. 98.3 $\text{g/kg BW}^{.75}$ for cows. AA of minerals was influenced by forage, animal species, and cutting. For alfalfa, AA of Mg was higher for sheep than for cows, but not different for orchardgrass; AA of Ca, P, and S were equivalent for sheep and cows fed alfalfa, but AA of Ca and P were higher for cows on orchardgrass than for sheep. Mineral AA's were higher on regrowth than on first-cut orchardgrass, while for alfalfa there were no consistent differences in AA between cuttings.

Title: Development and Application of Laboratory Methods of Evaluating Forage Quality

Leader: W. A. Kendall (U.S. Regional Pasture Research Laboratory)

A meadow-vole bioassay was used to evaluate the relative significance and interactions of some antiquality plant constituents on intake of semisynthetic diets in single-meal treatments. Three alkaloids, gramine, tryptamine, and hordenine, found in reed canarygrass, and 3-nitropropionic acid (NPA), found in crownvetch, were fed in various concentrations and combinations. Inhibition of intake by hordenine was less on a weight percentage basis but equal on a molecular basis to gramine, tryptamine, and NPA. The inhibitory effect of the alkaloids on intake was additive, and a synergistic effect was obtained with diets that contained mixtures of gramine and NPA. It was concluded that hordenine should get greater attention than it presently receives in plant breeding work with reed canarygrass, and further studies of the interactions of these compounds on intake by beasts appear warranted.

Title: Alfalfa Quality Reduced by Phoma Leafspot

Leaders: K. T. Leath, W. A. Kendall (U.S. Regional Pasture Research Laboratory), and J. S. Shenk (The Pennsylvania State University)

The effects of foliar disease caused by Phoma medicaginis on alfalfa quality were investigated with greenhouse-grown, moderately diseased (about 25% of leaf surface) Saranac alfalfa. Diseased and healthy leaf samples were compared for six quality constituents, in vitro dry matter disappearance (IVDMD), palatability to adult meadow voles, and the performance of weanling voles fed the alfalfa at 60% of their diets.

The quality constituents of diseased leaves differed from those of the healthy leaves as follows: acid detergent fiber, up 55%; cellulose, up 34%; cell walls, up 32%; lignin, up 300%; protein, down 31%; total nonstructural carbohydrates, down 44%. The IVDMD of diseased samples was 75% compared to 83% for healthy alfalfa leaves.

Palatability to adult voles was assayed in 0.5-hr feeding trials with the voles having a choice between the test sample and their usual mouse chow. The voles ate 0.25 g of diseased leaves, which was less ($P > 0.05\%$) than the 0.35 g of healthy leaves eaten. Weanling meadow voles were fed the following diet formulation: alfalfa leaves, 60%; carbohydrate, 35%; vitamins, 1%; mineral, 3%; and oil, 1%. The voles ate significantly more of the diseased alfalfa diet than they did of the diet containing healthy leaves, but weight gains were the same for voles on either diet. The digestible dry matter of the diseased alfalfa diet was 12% lower than that of the healthy alfalfa diet.

Alfalfa leaves moderately diseased with Phoma leafspot were lower in quality, were less palatable to adult meadow voles, and were less nourishing to weanling voles than were comparable healthy leaves.

Title: Effects on Rumen Fermentation of Magnesium Oxide Supplementation to an All-Corn-Silage Ration

Leader: H. Fenner (University of Massachusetts)

Feeding trials of 4 x 4 latin square design with four rumen fistulated Holstein cows served for determining the effects of supplementing 0, 60, 120, and 180 g/day of magnesium oxide to an intake-constant diet of corn silage. The rations containing 1.23, 4.30, 7.37, and 10.43 times the NRC recommended requirements for magnesium were prepared just prior to feeding and offered in portions of 1/3 and 2/3 according to the arranged time intervals between the two daily feedings. Parameters for assessing changes in rumen fermentation were pH, concentrations of total acids and bases, acid ratios of seven individual acids in the total acid content, and the concentrations of dissolved Na, K, Ca, and Mg in the fluid.

The supplementation caused significant linear increases in pH, the proportions of acetic acid in the total acids, and the concentrations of dissolved calcium and magnesium. Significant linear decreases were observed in the concentration of ammonia, the proportions of n-valeric acids of the total VFA's, and the concentrations of dissolved sodium and potassium in the rumen fluid. Concentration of total VFA's and the proportions of propionic, isobutyric, n-butyric, and isovaleric acids in the total VFA's changed little, if at all.

The up-to-40-percent decrease in concentration of ammonia with the seven-fold increase in dissolved magnesium is explainable by: (1) the formation of an ammonium-magnesium-phosphate complex formed and precipitated under the prevailing conditions in the rumen, and (2) by a slight increase of the passage rate through the digestive tract as a typical side effect for the consumption of MgO. An increased passage rate also explains the significant decreases in the dissolved portions of both sodium and potassium. The interaction of ammonia and magnesium described above, and a 60% decrease in dissolved magnesium found with the urea supplemented diets of the previously reported experiment using the same cows and base rations, indicate the formation of the ammonium-magnesium-phosphate complex at elevated pH in the rumen. As the rumen has recently been identified as the location for absorption of most of the needed magnesium, the formation of this complex can serve as a valid explanation for the occurrence of grass tetany or hypomagnesemia to cows on diets rich in protein and only marginal in magnesium content.

Title: Feeding Dried, Immature Forages as Grain Substitutes for Ruminants

Leader: W. P. Apgar (University of Maine)

Digestibility and energy-metabolism studies of four forms of immature forages are being started with sheep as part of an evaluation of the nutritive characteristics and animal feeding effects of processed, immature forages as partial substitutes for feed grains. Alfalfa and timothy forages harvested at immature stages were each dried and processed for

feeding in two forms, i.e., as chopped hay and as pelleted material. Chemical analyses and feeding trial preparation are currently in progress. Data from these immature forage studies will contribute to the regional objectives of identifying key physical and chemical factors influencing forage intake and digestibility as well as that of minimizing the use of expensive cereal grains in ruminant production.

Title: Utilization of Digestible Energy in Cattle

Leaders: H. F. Tyrrell, P. W. Moe, and P. J. Reynolds (Beltsville Agricultural Research Center)

Previous experiments have shown that acetic acid, a major end product of digestion of forage diets consumed by ruminants, is used with efficiency of 30% for body tissue synthesis when added to forage diets, but 70% when added to a high-grain diet. In a second series of experiments, acetic acid added to a high-forage diet was used with essentially 0% efficiency for body tissue synthesis compared to near 70% utilization of glucose infused into the abomasum. Utilization of a combined infusion of acetic acid into the rumen and glucose into the abomasum was nearly equal to that of glucose alone. An experiment is in progress to test whether the response to amount of acetic acid infused is linear. Instrumentation to measure entry rate of specific metabolites into the metabolic pool simultaneous with respiratory exchange is now available and work is in progress to bring this measurement system into operation.

A third experiment in a series to evaluate the utilization of energy and nitrogen by growing dairy cattle fed orchardgrass-silage diets is in progress, along with a companion growth-and-slaughter balance experiment. Previous experiments indicated that growth rate (weight gain) was directly related to nitrogen balance but independent of energy balance. The hypothesis being tested is that solubilization of nitrogen during the preservation of direct-cut, hay-crop silage results in energy retention in the form of body fat rather than body protein.

Title: Energy Value of Feedstuffs on Dairy Cattle

Leaders: P. W. Moe and H. F. Tyrrell (Beltsville Agricultural Research Center)

Percentage of crude protein (CP) in the diet significantly affected the metabolizable energy (ME) value of diets of lactating cows at high intakes. Diets of 14, 17, and 20% CP had 54.5, 58.2, and 58.7% metabolizable energy, respectively. A substantial portion of the lower ME value of the low-protein diet was associated with relatively low digestibility (92%) of the starch fraction of the diet. An important interaction was found between percent CP and intake effects on ME value. The percent ME at a maintenance intake was 59.4, 59.8, and 60.6, respectively. The difference in ME value associated with intake effects was therefore 4.9, 1.6, and 1.9 percentage

units which indicates that intake effects on energy value of the diet are significant with diets formulated to be adequate in protein, and that production responses which have been noted by higher protein feeding may be due to increased energy availability.

Title: Formaldehyde and Other Additives for Ensiling Forages

Leaders: D. R. Waldo and H. K. Goering (Beltsville Agricultural Research Center)

Nitrogen balance was determined in a 2 x 3 factorial experiment using either untreated or formaldehyde treated, direct-cut orchardgrass silage fed either without supplement, with corn meal, or with formaldehyde-treated casein. Nitrogen balance was a function of insoluble nitrogen intake as measured in autoclaved rumen fluid. The equation was $Y = .71X - 13.58$ with $r^2 = .988$ where Y = nitrogen retention, g/day and X = insoluble nitrogen intake, g/day. Nitrogen retention was proportional to insoluble protein intake in silage rations even though crude protein intake was adequate.

A commercial bacterial silage additive, SilaGain, did not increase recovery of alfalfa, orchardgrass, and corn silage dry matter from 4 x 8 silos (94 vs. 92%) nor the recovery of alfalfa and orchardgrass silage dry matter from 10 x 40 silos (78 vs. 80%). The digestibilities of silage dry matter from the small silos as determined by sheep were also unaffected (61 vs. 62%). The digestibilities of silage dry matter from the large silos as determined by dairy heifers were identical whether treated or not (65.5%). Dairy heifer gains were slightly better on the treated orchardgrass silage but slightly better on the control alfalfa silage with an average of .65 kg/day on control silage and .71 kg/day on treated silage.

Title: Influence of Heat and Other Processing Variables on the Utilization of Forage Nitrogen

Leaders: H. K. Goering and D. R. Waldo (Beltsville Agricultural Research Center)

Whole corn plants were ensiled with 0 (U), .05 (LC), and .1 (P)% paraformaldehyde and fed to lactating cows and growing heifers. The lactation diet consisted of 60:40 corn silage to concentrate ratio. A high NPN containing concentrate (U) and a low NPN containing concentrate (S) were used. The milk production results were (U) 31.1, (LC) 31.1, and (P) 31.6 kg/cow/day. The soybean-supplemented concentrate resulted in 32.7 kg/day compared to 29.8 kg/day for urea supplemented concentrate. Insoluble nitrogen concentration of the diets was 73% of the total nitrogen for S concentrate, compared to 50% for the U concentrate.

Direct-cut alfalfa was ensiled for 98 days without an additive (U), with 7.5% corn meal (TC), or with 7.5% cottonseed hulls (TCH). Energy, neutral-detergent solubles, and sugar recoveries were 84, 94, vs. 98%; 59, 68, vs.

61%; and 3.8, 12.6, vs. 3.6% for U, TC, and TCH. Lactic acid percentage in dry matter and pH were 2.2, 10.6, vs. 0.6; and 5.0, 4.0, vs. 5.3. Twenty-eight Holstein heifers (270 kg) were fed U plus corn meal or cottonseed hulls, TC, or TCH for 63 days. Daily gains were 834, 363, 650, and 337 g/day. Intakes were reduced on corn meal silage which accounted partially for reduced gains.

Title: Growth and Physiological Parameters of Ruminants Grazing on Different Varieties of Fescue Pasture

Leaders: J. Bond and J. B. Powell (Beltsville Agricultural Research Center)

Thirty-two steers in 1976 and 48 steers in 1977, averaging 226 and 276 kg, respectively, grazed 168 and 126 days on Ky-31, Kenhy, or two experimental varieties (Gl-306, high perloline, and Gl-307, low perloline) of Festuca arundinacea Schreb. Trained observers monitored the behavioral activity of all steers at 1300 hr and the number of steers per paddock was recorded as to these categories: lying in field, shade, water; standing in field, shade, and water; standing at water tank; grazing; drinking; and licking salt. The categories with the highest frequencies included: lying in field (13%) and shade (17%); standing in field (20%) and shade (19%); and grazing (40%). In 1977 lying in the field was negatively correlated with ambient temperatures and positively correlated with sky condition, and lying in shade was positively correlated with temperatures and negatively correlated with sky condition. In both 1976 and 1977, standing in field was negatively correlated with temperature while in 1976 standing in shade was positively correlated with temperature and negatively correlated with sky condition. Grazing was positively correlated with cloud cover. Steers grazing Gl-307 stood in shade 44% more and in water (1977) 79% more; laid in field (1976) 27% less and in shade (1977) 29% more; grazed 40% less and showed signs of emaciation, rough haircoat, elevated respiration, and lower gains, compared to steers grazing Gl-306, Ky-31, and Kenhy.

Title: Effects of Grinding and Pelleting on the Nutritive Value of Complete Dairy Rations

Leaders: H. K. Goering and W. E. Wheeler (Beltsville Agricultural Research Center)

A feeding trial was conducted with 30 lactating dairy cows fed corn silage and corn-grain-based complete, mixed rations consisting of 60:40 forage-to-concentrate dry matter ratios to evaluate the use of limestone as a buffer. For the first 120 days of lactation, cows fed the buffered ration produced 1.2 kg more milk per day and consumed the same amount of feed dry matter as cows fed the unbuffered ration. During the remaining 185 days of lactation, there were no differences in actual milk production; however, cows fed the buffered ration consumed 9.2% less feed dry matter per day. The feeding trial data indicate that the buffered ration was more efficiently utilized and agree with results from digestion trials previously reported.

A trial was initiated to study the influence of cement-kiln dust on feedlot performance of finishing steers. Diets were 53% forage and 47% concentrate, on a dry basis. The control diet was formulated to satisfy all currently known nutrient requirements for finishing steers. The experimental diet contained the same forage-to-concentrate ratio and 3.5% cement-kiln dust but no supplemental protein, minerals, or salt. Steers fed the diet containing cement-kiln dust had a .29 kg higher (1.04 vs. 1.33) average daily gain and a 21% improved (10.89 vs. 8.62 kg) feed/gain ratio during the 112-day trial. The data indicate that cement-kiln dust from Georgia had a beneficial influence on the performance of finishing steers fed relatively high forage diets.

Title: Nutritive Evaluations of Animal Excreta and Cellulosic Crop Residues for Ruminant Feed

Leaders: L. W. Smith and C. C. Calvert (Beltsville Agricultural Research Center)

A nitrogen (N) supplement (SPE) containing barley straw, 25.0; beet pulp, 23.9; limestone, 18.4; soybean meal, 14.0; urea, 10.3; and monosodium phosphate, 8.4% was mixed to simulate the composition of DPE. The DPE contained N, 6.3; cell walls, 37.0; Ca, 8.0; P, 2.8; and ash, 25.0%. Protein N was ca 29% of total N in both supplements. Uric acid N was 52% of total N in DPE, and urea N was 68% of total N in SPE. Four diets from each of the two supplements were formulated to contain 12, 18, 24, and 30% crude protein. All diets were balanced with ground ear corn, barley straw, and salt to contain ca 60% TDN. Two lambs of 29.4 kg were randomly assigned each of the eight complete pelleted diets and fed ad lib. Nutrient digestibilities were determined after feeding the diets for 20 and 45 days by two 5-day total excreta collection periods. Data from the two periods were combined because of nonsignificant differences. Lambs fed SPE diets consumed less ($P < .05$) digestible organic matter (OM) than lambs fed DPE (24.6 vs. 28.9 g/W^{.75}kg daily). Digestibilities of organic matter (56.5 vs. 58.4%) were not different due to supplementation of SPE or DPE. Hemicellulose (51.4 vs. 65.6%) and cellulose (52.9 vs. 58.7%) were less digestible ($P < .05$) in SPE diets than DPE diets. Nitrogen (76.8 vs. 70.9%) and detergent solubles (65.9 vs. 71.2%) were more ($P < .05$) digestible in the SPE diets than DPE diets. Increased level of crude protein resulted in decreased ($P < .05$) organic matter intake but in increased ($P < .01$) digestibilities of OM, hemicellulose, cellulose, and N. Interaction was not significant ($P > .10$) for any of the measurements. Lambs fed DPE diets excreted more uric acid (214 vs. 50 mg/day) than lambs fed SPE. Urinary uric acid was not related to level of uric acid intake. True digestibility of nitrogen (107 vs. 96%) was higher ($P < .01$) in SPE diets than DPE diets. The theoretical maximum true digestibility of nitrogen is 100% in this model. The true digestibility of N in DPE is biologically similar to that in a urea-soybean meal mixture.

Title: Environmental Microbiological Aspects of Digestion and Use of Cellulosic Crop Residues by Ruminants

Leader: M. E. Simpson (Beltsville Agricultural Research Center)

Monensin, narasin, tylosin, chlortetracycline (CTC), and vancomycin, antibiotics with use or potential use for improving feed efficiency with cattle, were tested in a balanced incomplete block experiment to determine their effect on in vitro cellulose digestibility with unadapted ruminal microorganisms. Monensin and narasin at 1 ppm in the fluid depressed cotton cellulose digestibility in a 48-hr in vitro incubation from 45 to 2.0 and 16.7%, respectively. Narasin, tylosin, CTC, and vancomycin at 10 ppm depressed cellulose digestibility to 0.3, 0.8, 38.4, and 39.6%, respectively. VFA's were determined on fluids from the same incubation flasks. Total VFA production and cellulose digestion were inversely related to concentration of monensin, narasin, or tylosin. Increasing concentrations of CTC or vancomycin had little depressing effect on cellulose digestion and VFA production. Increased concentrations of monensin, narasin, and tylosin resulted in a change of the acetate:propionate ratio from 2.0 (control) to >3.0 for 1 to 10 ppm antibiotic. This ratio was 1.8 to 2.0 with CTC or vancomycin at all antibiotic levels tested. Butyrate:propionate ratios showed similar responses to increasing concentrations of the antibiotics. The antibiotics used in this study can be ranked on the basis of their effect on in vitro cellulose digestion with unadapted ruminal microorganisms; those compounds that are most effective in improving feed efficiency are the same ones that produce the greatest initial shock to the organisms, as evidenced by depressed cellulose digestion and VFA formation.

Title: Intestinal Microorganisms and their Contribution to Animal Health

Leader: L. L. Slyter (Beltsville Agricultural Research Center)

A greater proportion of the total rumen lactic-acid fermenting bacteria was found to grow and ferment lactic acid at pH 5.0 from cattle fed all-concentrate diets than from cattle fed silage or hay diets. This would suggest that if the rumen becomes acidic (pH 5.0 or less), the ruminant animal adapted to forages may have acidosis problems after consuming high concentrate diets because its bacteria have less capacity to ferment lactic at pH 5.0. The relative numbers of bacteria with different physiological characteristics from cattle fed all-concentrate, corn, or orchardgrass silage, or orchardgrass-hay diets were determined. The rumen digesta contained the following bacteria (10^8 /g) for heifers fed the above four diets, respectively: viable, 93, 26, 20, 15; lactobacilli, 7.2, 0.3, 0.3, 0.07; cellulose hydrolyzers, <.06, 1.9, 4.6, >7.4; and urea hydrolyzers, 7.4, 0.9, 0.1, and 0.7. Using an artificial rumen continuous culture, it was found that if methane was completely inhibited by dichloroacetamide, monensin reduced the acetic to propionic ratio of the end-products formed. It is, therefore, suggested that the beneficial shift in the acid production noted when monensin is fed to ruminants can occur independent of

whether propane is serving as a hydrogen sink or not in the fermentation process. The propionate enhancer, monensin, also reduced the inhibition by dichloroacetamide (a methane inhibitor) on plant cell-wall digestion and acid production by rumen microbes. The combination of monensin and dichloroacetamide also resulted in less hydrogen and formic acid as end-products of rumen fermentation. It is, therefore, suggested that when methane is sufficiently inhibited to cause the adverse effect of hydrogen accumulation, the rumen ecosystem can benefit from a propionate enhancer, such as monensin, by diverting hydrogens otherwise lost as an energy source to the animal to propionic acid which it can use.

Title: Optimizing Intake and Digestibility of Forages

Leaders: P. J. Wangsness, B. R. Baumgardt, J. S. Shenk, and W. L. Kjelgaard (The Pennsylvania State University)

Accurate means of predicting feed intake from easily measured dietary and animal characteristics will aid in formulating rations to better meet animal requirements. Previous data from growing wether trials revealed that the following diet characteristics accounted for >80% of the variation in intake of legume and grass forage based diets: density, in vitro dry matter digestibility, % neutral detergent fiber (NDF), NDF digestibility, and rate of in vitro NDF digestion. Recent studies revealed that diet factors significantly related to intake of sheep fed seven-corn-silage based diets were some of the factors important in predicting intake of legume or grass diets. A study with lactating dairy cows was designed to extend knowledge on predicting intake gained in the sheep work. Two complete mixed isonitrogenous rations (77% chopped alfalfa or brome-grass hay + 23% concentrate) were fed to 20 lactating cows and growing wethers. NDF levels of the alfalfa and grass diets were 48 and 53%. Dry matter intakes (% of body weight) were 3.25 and 2.69 for alfalfa and grass diets; digestibility of the grass diet, however, was higher than for alfalfa. Bulk density of the as-fed diets was more closely related to dry matter or energy intake than density of the ground sample. Measured digestible energy values for the rations fed to cows were lower than NRC values for cows. Estimated (NRC) and determined values for sheep were similar. These findings support other reports regarding shortcomings of NRC standards for lactating cows.

Title: Breeding Forage Grasses and Evaluation with Infrared Reflectance

Leaders: J. S. Shenk, M. L. Risius, and R. W. Cleveland (The Pennsylvania State University)

A comprehensive breeding program to improve yield and quality of orchard-grass was continued with four source populations (A, B, C, D) of over 10,000 plants. Each population was reduced to 100 to 200 plants, divided into maturity groups, and crossed in open-pollinated groups of 50-100 plants. Seed was obtained from plants in the second cycle of population A.

Progeny were selected after a 2-year evolution of population B. Progeny of 150 plants from population C were established in field plots to be harvested next year. Progeny from 100 plants in population D will be established in small plots (1 to 1.2 m) next spring.

Details on the first year analyses of plants from population B were as follows. Seed from 72 plants was planted in a triple lattice design and the forage harvested three times. Plots were harvested for dry matter yield with a small flail harvester. The harvested forage was subsampled for quality analyses and analyzed by the infrared reflectance spectro-computer. Yield and predicted protein, digestibility, and neutral detergent fiber (NDF) data were transferred to the computer Dairy Herd Simulation Program to estimate net \$/ha profit for each entry. Entries ranged from 15.8 to 18.0% protein, 64 to 66% digestibility, 58.0% to 61.3% in NDF, and 132 to 146 in \$/ha relative to Pennlate. Entries were identified that had significantly higher yield and/or quality than the progeny from the four parental plants of Pennlate. Five plants had significantly higher \$/ha index values than the Pennlate progeny. It seems reasonable that upon continuation of the breeding and selection program over a number of cycles that germplasm can be developed that will exceed \$200/ha over existing varieties.

Title: Partial Replacement of Concentrate by High-Quality Forage in the Diet of High Producing Cows

Leaders: E. J. DePeters, E. M. Kesler, and J. M. Buckalew (The Pennsylvania State University)

The objective was to determine whether high-quality, ground forage could be substituted for concentrates in the diet of cows in early lactation. An alfalfa-grass mixture, third cutting, harvested in bud stage, and heat finished was ground through a 1.3 cm screen. It was incorporated into concentrate mixtures at levels of 0, 20, or 33%. The mixes were intended to be isonitrogenous (20% crude protein) and to contain equal minerals. Each cow was fed 3.6 kg long alfalfa daily. Concentrate and corn silage were offered to each to extent of appetite. Proportions of concentrate and corn silage were set initially at a level calculated to meet nutrient needs for 35 kg production, assuming average feed intake and the 0% concentrate mix. Proportion of concentrate was reduced with decreasing production as lactation advanced. Ten Holstein cows were assigned to each group, based on previous lactation production and parity number, at 15 days postpartum. Period of observation was 168 days. There was no significant difference in total dry matter intake between the 0, 20, and 33% treatment groups; the average daily intakes were 20.9, 21.4, and 22.2 kg, respectively. Daily milk production averaged 32.3, 31.5, and 30.5 kg, respectively by the three groups and was not significantly different. Total dietary crude protein percentages for the three treatments were 16.7, 15.9, and 15.3%, significantly different because purchased concentrate ingredients, especially soybean meal, were higher in protein than anticipated. Total protein intakes were 586 ± 75 , 572 ± 92 , and 574 ± 127 kg for treatments 0, 20, and 33%, respectively, and were not significantly different.

Title: Productivity and Composition of N-Fertilized Grass and Grass-Legume Pastures under Grazing Conditions

Leaders: L. L. Wilson, P. C. Lootens, D. D. Fisher, and W. C. Stringer
(The Pennsylvania State University)

Productivity (dry matter (DM), digestible dry matter (DDM), crude protein (CP) yields; carrying capacity; calf gain/ha; beef-cow weight gain) and composition (botanical and macromineral) of rotationally grazed pastures of tall fescue, orchardgrass, and smooth brome grass, with and without birdsfoot trefoil, were evaluated for a 154-day grazing season. Grass-legume cows gained more weight ($P < .05$). N-fertilized grasses (+168 kg N/ha/yr) yielded 84.7 kg more calf/ha than mixed swards (24% legume). Fescue (+N) had higher total DM and DDM yields than did fescue-trefoil ($P < .05$). Likewise, orchardgrass (+N) yielded more DM and DDM than did orchardgrass-trefoil ($P < .01$). Orchardgrass (+N), brome grass (+N), orchardgrass-trefoil, and brome grass-trefoil DM and DDM yields decreased during the latter part of the grazing season ($P < .05$). Orchardgrass (+N) and brome grass-trefoil CP yields also decreased ($P < .05$). Fescue (+N, no N) had higher Mg contents than did brome grass (+N, no N; $P < .05$). Orchardgrass (no N) and brome grass (+N, no N) increased in Ca content during summer and fall ($P < .05$). Fescue (+N) was higher in Ca during spring and fall ($P < .05$). Orchardgrass (+N) had elevated K in spring ($P < .05$). Orchardgrass (no N) and brome grass (no N) increased in Mg during late summer-fall ($P < .05$). Orchardgrass (+N) had the highest K/(Ca+Mg) ratio, 2.2.

Title: Factors Contributing to Hypomagnesemia in Lactating Angus and Angus-Charolais Cows on Pasture

Leaders: D. D. Fisher, L. L. Wilson, P. C. Lootens, R. W. Scholz, and W. C. Stringer (The Pennsylvania State University)

Factors contributing to hypomagnesemia in lactating beef cows, which rotationally grazed tall fescue, orchardgrass, and brome grass pastures with and without birdsfoot trefoil during a 154-day season, were studied. Soil, forage, blood, and urine samples were collected for macromineral analyses. Botanical compositions were determined. Meteorological conditions were recorded. No significant differences in pasture soil composition were detected. Legumes contained more N and Ca ($P < .01$) than grasses. Legumes, N-fertilized grasses and unfertilized (no N) grasses all differed in Mg ($P < .05$). Fourteen cows grazing N-fertilized grasses had lower blood and urinary-Mg levels ($P < .01$) than ten grass-legume cows on similar Mg intakes/animal unit. The N-fertilized grass group had higher forage-K intake and a higher ($P < .01$) urinary-K concentration. Highest blood and urinary-Mg levels occurred on brome grass; blood Mg on tall fescue was intermediate; and lowest blood Mg was on orchardgrass ($P < .01$). Cows had a higher blood Ca ($P < .01$) and lower blood K ($P < .01$) on brome grass, and lower urinary Ca ($P < .05$) and higher urinary K ($P < .05$) on orchardgrass. Three young cows had higher blood Ca, Mg ($P < .01$) and K ($P < .05$) than 21 mature cows; 11 Angus cows had lower blood Mg ($P < .07$) than ten Angus-Charolais.

Title: Optimizing Intake and Digestibility of Forages by Ruminants

Leaders: J. L. Evans, Z. Lelkes, P. Zajac, D. Yoon (Rutgers University)

A third major trial associated with this project area was completed at the animal level; however, only the dry-period data have been completed. These data from 42 and 44 cows were summarized in theses by Basch and McKinley. The 2 x 2 arrangement of treatments was constituted by age at calving (25 and 41 months) and diet Ca (0.32 and 0.54%). The 0.32% Ca diet resulted in 25 and 31 g Ca ingested/day for younger and older cows; 0.54% Ca, 42 and 48 g Ca/day. Data from the previous trial constitute the basis for reassessment of the diet requirement for Ca in high producing dairy cows. Twenty-four cows (12 first calf and 12 older) were fed five diet-Ca levels in dry period (.26, .34, .44, .57, and .70%) and five diet-Ca levels in lactation period (.22, .39, .72, 1.04, and 1.24%), constituting a central composite arrangement of treatments for nine response groups in the lactation period. Corn silage and grain were fed at a 1:1 ratio (dry basis) and limited to 11 kg/cow/day in dry period. Corn silage was fed ad libitum during lactation. Ground limestone was the source of variable diet Ca. Balance studies on dry matter and minerals were carried out on days 35, 15, and 5 precalving and days 10, 20, 40, 80, and 140 postcalving. Endogenous fecal Ca obtained by regression analysis of all data was 19.4 mg/kg body weight. Limiting the analysis to lactation data only, endogenous fecal Ca was 7.1 mg/kg body weight. Acidifying grain tripled endogenous Ca; however, older cows benefited in retained Ca at parturition. Apparently absorbed Ca was 25% precalving and 33% postcalving. Grams of absorbed (true) and retained Ca were maximized at 22 and 27 g/100 kg body weight. Thus, a 50% increase over current NRC Ca is required to maximize milk production.

The lactation part of the third major trial, as noted above, should be completed with respect to laboratory analyses during the coming year. Data summaries will follow. In addition, a fourth lactation trial was started. Objectives deal with the influence of diet calcium on voluntary dry matter intake, milk production, and calcium utilization. Diet calcium will be maintained at 60 to 70 g/cow/day from 60 days precalving to 42 days postcalving. From lactation day 43, responses to four diet calcium levels will be determined. The diet calcium levels will be 70, 100, 130, and 160 g/cow/day.

Title: Optimizing Intake and Digestibility of Forages by Ruminants

Leaders: J. G. Welch and A. M. Smith (University of Vermont)

Factors affecting rumination, rumen-ingesta consistency (RIC), and rumen-particle mobility in fistulated steers were studied in several experiments. RIC was not correlated with rumen-particle mobility. It was, however, correlated ($P < .05$) with dry-matter intake, rumen dry matter and rumination time. Different dry-matter intakes did not influence the time necessary for colored particles to travel to the upper reticulum (area of the reticulo-omasal orifice) from various parts of the rumen. Transit time

from the dorsal rumen sack to the reticulum was longer than from the central rumen. There was wide variation in RIC among animals and days. Bundles of loose polypropylene ribbon roughly 20 cm x 20 cm x 40 cm maintained in the reticulum inhibited rumination and intake. Infusion of 0.03% H₂O₂ into rumen ingesta inhibited intake and defaunated the rumen fluid. The influence of body size on rumination efficiency in mature cattle was determined. Body size ranged from 364 kg with 155 min rumination per kg CWC (cell wall constituents) to 861 kg with 73 min rumination per kg CWC. The regression is described by the equation $Y = 248.5 - 0.900X_1 - 1.1007X_2$ where Y = rumination time (min)/kg CWC intake, X_1 = BW^{.75}kg. Rumination time and chewing time per kg CWC varies, but total chewing time per kg CWC is constant with intake varying from 4.37 kg to 8.53 kg in mature, dry Holstein cows. Fecal particle size is constant over this intake range.

Title: Effect of Monensin and Ralgro on Performance of Steer Calves on Pasture

Leaders: W. E. Kunkle, E. C. Leffel, C. McCullough, R. C. Hammond, and L. W. Douglass (University of Maryland)

The effects of feeding Monensin and implanting Ralgro on pasture-fed growing steers were investigated. Forty-one Hereford and Angus steers were assigned to Monensin and Ralgro treatments after weaning in September. The Monensin was offered in a commercially formulated salt block. The cattle were pastured on bluegrass-clover and fescue pastures during the 84-day trial.

The steers gained 1.9 lbs/hd/day on bluegrass pastures during October and November, but this decreased to 1.2 lbs/hd/day when switched to accumulated fescue pastures during November and December. The steers consumed .38 lbs/hd/day of the control block, but only .13 lb/hd/day of the block containing 400 mg of Monensin/lb during the 84-day trial.

Monensin-fed steers gained similarly to controls during the first 56 days of the trial (1.55 lbs) but performed better than controls during the last 28 days (.29 vs. -.25). The increased performance resulted during a period when the consumption of Monensin was lowest.

Steers which were implanted with Ralgro gained 17% faster than controls (1.10 vs. 0.95).

Title: Composition and Feeding Value of Broiler Litter

Leaders: W. E. Kunkle, L. Carr, T. A. Carter, and B. Harmon
(University of Maryland)

The composition, storage, and feeding of broiler litter were investigated. The crude protein and mineral content of broiler litter increased with the number of flocks. Five-flock broiler litter analyzed 25% moisture, 25% crude protein, 1.8% calcium, and 1.4% phosphorus.

Broiler litter stored in piles goes through a heat and usually acquires a sweet, caramelized odor. The temperatures peaked at 130 to 150° F in two piles but some piles have been observed to char. The nutrient content remains nearly constant during storage. Broiler litter ensiled best at a moisture content of 35 to 40%.

Growing calves fed corn silage had similar gains when supplemented with soybean meal or broiler litter (1.5 lbs/hd/day). Diets containing 40% or more of broiler litter produced good results in maintenance animals, but were too low in energy for growing cattle. Supplement broiler litter is worth 50 to 60% as much as soybean meal as a protein supplement.

Title: Supplemental Protein for Gestating Beef Cows Fed Corn Residue

Leaders: W. E. Kunkle, E. C. Leffel, J. Buric, L. W. Douglass
(University of Maryland)

Corn-residue stacks, corn-residue grazing, and conventional hay feeding were compared as feeding systems for gestating beef cows. The corn-residue stacks were supplemented with liquid supplement, soybean meal, alfalfa hay, or not supplemented (controls). Part of the cows were injected with Vitamin A and part were wormed.

The cows fed conventionally gained weight (1.64 lbs/hd/day), but the cows fed corn residue lost weight. The cows grazing corn residue lost 0.5 lb/hd/day in December and early January, but lost considerable weight (2.8 lbs/hd/day) during cold weather when snow covered the ground. The cows fed corn residue stacks supplemented with alfalfa hay, soybean meal, liquid supplement or controls lost .46, 1.11, 1.64, and 1.99 lbs/hd/day, respectively, during the 56-day trial. The cows supplemented with preformed protein lost less than those fed a liquid supplement containing nonprotein nitrogen. All the cows calved and had healthy calves with similar birth weights. Vitamin A injections or worming did not effect cow performance.

Title: Infrared for the Nutritive Evaluation of Crops and Miscellaneous Feedstuffs

Leaders: J. S. Shenk, M. R. Hoover, B. R. Baumgardt (Pennsylvania State University), W. C. Templeton, Jr., and G. W. Fissel (U.S. Regional Pasture Research Laboratory)

Our studies, using simulation, indicate that commercial instruments containing the six filters proposed for forages (1.672, 1.70, 1.94, 2.10, 2.18, and 2.336 μm) should be able to predict the protein of cereal grains with a standard error of 0.3% and predict in vitro dry matter disappearance (IVDMD) with an error of $>2.0\%$. The prediction of forage protein would be approximately 1.0% and IVDMD between 3.0 and 3.5%.

Prediction of forage quality for 200 samples of mixed forage species with our infrared spectro-computer system is 0.9% for protein, 2.5% for IVDMD, 1.8% for acid-detergent fiber, 1.5% for lignin, 2.2% for neutral-detergent fiber, and 1.5% for cellulose. These prediction errors can be reduced further if specific equations using different wavelengths are developed for each species. It appears possible to determine by infrared analyses the percentage of legume in a sample of mixed species with an error of $\pm 10\%$. This may allow the computer to choose the appropriate equation to predict the quality of the sample based on a preliminary test of the percentage legume in the sample. The detection and quantification of heat damaged protein in dehydrated alfalfa also appears possible. The region of the spectrum showing greatest change was from 1.17-1.35 μm .

First tests of the new, small, compact infrared spectro-analyzer (IRSA) we have developed were very encouraging. The instrument contains, rather than filters, a small monochromator to generate wavelengths. This allows "custom fitting" of equations for specific types of samples such as hay, silage, and grain, and provides the instrument user with lower errors of prediction, similar to those obtained on our larger infrared spectro-analyzer. Communication to and from the IRSA is by either cassette or floppy disk. The floppy disk option allows complete control of the system by the operator, while the cassette option relies on our 11/34 computer for the development of calibration equations.

Title: Studies on Allelochemical Properties of Crownvetch and Their Effect on Forage Quality

Leaders: D. L. Gustine, B. G. Moyer (U.S. Regional Pasture Research Laboratory), and P. E. Pfeffer (Eastern Regional Research Center)

A study of β -nitropropionic acid (BNPA) synthesis in plants was begun. Tissue cultures of crownvetch (Coronilla varia) were established, but did not produce BNPA or its glucose esters. Added BNPA is toxic to these cultures and prevents further growth. Tissue cultures of Astragalus spp. and Corynocarpus laevigatus could not be established, but a new glucose triester of BNPA, corynocarpin, as well as two triesters and two diesters we previously found in crownvetch, were isolated from Corynocarpus.

SECTION IX. SILAGE AND HAY RESEARCH

Title: Use of Forage Preservatives to Reduce Losses from the Field to the Cow

Leader: J. B. Holter (University of New Hampshire)

The objectives of this research are to (1) test commercial silage additives for their ability to control silo temperature, reduce storage loss, improve forage intake, and, as a result of improved fermentation pattern, enhance nutritive value; and (2) test a commercial hay preservative to determine its ability to control heating and mold and thereby to increase hay intake and nutritive value.

Alternate loads of treated (.05% dry SilageSavor, Kemin Industries, Des Moines, Iowa) and untreated (control) wilted mixed grass silage were ensiled at 30 to 50% DM in farm-sized tower silos. Porous plastic feed bags (duplicates at each of several depths) filled with each silage were buried in that silage, and nutrient storage efficiency determined upon recovery of the bags during the feeding season. Temperature measurements were made daily, then weekly, for approximately 100 days. Ad libitum intake was measured in bred Holstein heifers, and complete energy and nitrogen balances and nutrient digestibility were determined at near maintenance level of intake.

Hays from the same field were baled at 36% average moisture (untreated) 34, 29, and 21% average moisture (treated, .1% wet HaySavor, Kemin Industries) and 16% average moisture (untreated, field-cured). Temperatures in stacks of these conventional bales were monitored daily for 20 days. Then nutritive value was measured in heifers as noted above using 29 and 21% moisture treated and 16% moisture untreated hays.

In each of four comparisons, internal silo temperatures were lower (2 to 6° C) in treated silage throughout 100 days, but maximum temperature never exceeded 46° C in untreated silage. This effect on temperature was not found in one comparison with corn silage (0.25%, large bunker silo).

Treated silage was slightly lower in pH (4.2 vs. 4.58) and higher in lactic (7.27 vs. 6.62% of DM) and other organic acids in one comparison.

Dry matter storage efficiencies were higher for treated silage in each of three comparisons (81 vs. 80%, 87 vs. 85%, and 91 vs. 85%), returning \$.32, \$.57, and \$1.65 for each \$1.00 cost of additive.

Ad libitum DM intake in three comparisons (3 years) was not different, averaging 2.00 vs. 1.94 kg DM/100 kgW, for treated and untreated silages.

In one of two comparisons, digestibility of protein by heifers was 40% higher, and TDN and ME levels in DM were 12 to 13% higher in treated

than in control silage. These improvements in nutritive value returned approximately \$2.50 for every \$1.00 cost of additive. In one comparison, no improvement in nutritive value was found.

It was not possible to determine why an economic response to treatment was found in one year and not in another. Both treated and control silages were of high quality in all comparisons. It is likely that proper use of this commercial additive on wilted haycrop silage would consistently control silo temperature and, on average, return at least additive cost in terms of either improved storage efficiency or nutritive value.

Heating in treated hays was completely controlled at 21% moisture, partially controlled at 29% moisture, and not controlled at 34% moisture, compared with 16 and 36% moisture, untreated reference hays. Heavy mold and rotting were found only above 25% moisture, regardless of treatment. Proportions of bales with light mold were 56, 24, and 5% and with no mold were 31, 76, and 95% for 29% treated, 21% treated, and 16% moisture untreated hays, respectively. Corresponding relative ad libitum intakes of dry matter were 95, 97, and 100% (100% = 1.74 kg DM/100 kg W). At equal dry matter intakes digestibility of energy, dry matter, and crude protein were slightly but not significantly ($P > .05$) higher in 21% moisture treated than in 16% moisture untreated (field-cured) hays.

It is concluded that the hay preservative is effective only on hay baled with less than 25% moisture (as recommended) and that its economic value is in salvaging such haycrop from imminent weather damage rather than otherwise directly improving intake or nutritive value.

Title: Feeding Management Systems to Increase Efficiency of Dairy Production

Leaders: J. E. Keys and R. E. Pearson (Beltsville Agricultural Research Center)

Four complete ensiled diets: (1) 52.7% corn stover--38% chopped whole ear corn--9.3% poultry excreta (dry matter basis); (2) 95.2% corn silage--4.8% soybean meal; (3) 90% corn silage--10% poultry excreta; and (4) 67.5% corn stover--20.2% chopped whole ear corn--12.3% poultry excreta each fed to seven heifers resulted in .51, .56, .45, and .40 kg gain/day. Intakes of the coarser stover-silage diets were less (6 kg/day) than corn-silage diets (7.4 kg), indicating that chopping corn stover to a finer particle size may improve intake. A trial comparing the effect of four 65:35 (silage:concentrate) complete feeds that vary in proportion of corn and grass silage on milk production and health of second and third lactation cows is still in progress. Statistical models are being developed to unbiasedly estimate ration and housing effects on production, weight change, feed and nutrient intake, gross feed efficiency, health and reproduction traits, and involuntary losses in a previous trial which compared different forage:concentrate ratio complete feeds fed individually and in groups over two complete lactations and dry periods. Analyses will be interpreted and a manuscript prepared for publication.

Title: Hay Investigations

Leader: M. A. Sprague (Rutgers University)

An experimental, quick-reading hay moisture tester was evaluated for accuracy and reliability within the 25 to 35% moisture range. Mixtures and pure-stand hays from spring and summer cuttings of alfalfa, timothy, brome grass, and orchardgrass were represented. Statistical analyses indicated reasonable accuracy of the meter readings when compared with oven-dried samples when a large number of readings were taken. Too great variability existed between meter readings of the same sample with some hays. A redesigned sensor head to better sample different hays will be tested in 1978 as an effort to improve reliability.

Title: Factors Influencing Safety of Animal Wastes Processed for Livestock Feed

Leader: C. C. Calvert (Beltsville Agricultural Research Center)

Three experimental silages were prepared: control whole-corn-plant silage, whole-corn-plant silage plus limestone, and whole-corn-plant silage plus DPE. Limestone and DPE were added to provide equivalent amounts of calcium. Five experimental diets using the experimental silages and concentrate mixes are being fed to lactating cows. Silage and concentrates are mixed at time of feeding with silage providing 60% of dry matter and concentrate 40% of dry matter. The five experimental diets are: (1) control silage plus high limestone concentrate; (2) limestone silage plus low calcium concentrate; (3) control silage plus DPE concentrate; (4) DPE silage plus low calcium concentrate; and (5) control silage plus concentrate with NRC level of calcium. All diets are isonitrogenous containing, on a dry matter basis, an average of 18% crude protein. Calcium contents of the complete diets are: (1) 1.4; (2) 2.0; (3) 1.4; (4) 1.2; and (5) 0.8%, respectively. Silage crude protein, calcium, and phosphorus contents were: 8.5, .31, .34; 7.7, 1.70, .30; and 11.5, 1.95, and .74% for control, control and limestone, and control plus DPE, respectively. Heavy metals, copper, iron, zinc, and nickel contents for control, limestone, and DPE silages were 2.9, 983, 20.8, 1.9; 4.75, 2131.7, 19.4, 4.4; 6.9, 1118.7, 60.0, and 3.1 ppm, respectively. Five groups of seven lactating Holstein cows each have been on experiment for approximately 1 month.

Title: The Feeding of Corn Stover Silage to Dry Cows

Leader: J. H. Vandersall (University of Maryland)

Corn stover was harvested with a rotary mower within 2 days after the grain was harvested with a picker-sheller. The stover was harvested on a misty day with periods of light rain. Moisture of the stover silage was approximately 70%.

Fifteen cows were blocked into trios, according to expected date of calving and body condition. The cows in each trio were assigned at random to the following feeding programs 60 days prior to expected calving:

1. Alfalfa hay (2.27 kg/day) and regular corn silage (55% moisture) ad libitum
2. One-half regular corn silage and one-half stover silage (dry matter basis) plus 1.36 kg of a 40% protein concentrate per day
3. Stover silage ad libitum and 1.59 kg of a 40% protein concentrate per day

The effects of these diets on body weight, health at calving, and the first 60 days of lactation will be evaluated. This trial is in progress at the present time, and no results are available. Acceptability of the stover silage has varied greatly among animals.

Title: Alfalfa-Corn Stover Silage for Replacement Heifers

Leader: J. H. Vandersall (University of Maryland)

A trial was conducted to compare wilted-alfalfa silage to direct-cut alfalfa silage with 12% air-dried corn stover added before fermentation (240 lbs. per ton of wet alfalfa). The direct-cut alfalfa was drier than normal (24.5% dry matter), and with the addition of the stover, the silage contained 29.9% dry matter. Wilted silage made from the same field the following day contained 47.4% dry matter.

Sixteen yearling Holstein heifers were paired and randomly assigned to receive the silted-alfalfa silage or the silage containing stover. Each animal was fed 1.81 kg of concentrate per day. Average daily body-weight gain during the 8-week trial was a very satisfactory 654 g, while animals fed wilted alfalfa gained 908 g. Average daily silage dry matter consumption was 5.4 kg for those fed alfalfa-stover silage, and 7.9 kg for those fed wilted silage. While animals fed silage containing stover did not gain the standard 750 g per day, their condition was satisfactory, as were their feed/gain ratios.

Title: Nutritive Value of Direct-Cut Alfalfa Ensiled with Various Types and Levels of Newspaper

Leaders: T. L. Horn and J. H. Vandersall (University of Maryland)

One intake and two digestion trials with steers were conducted on: wilted alfalfa silage; 15% "newspaper silage" (85% direct-cut alfalfa as harvested, and 15% newspapers); and 7.5% newspaper silage (an equal mixture of the above silages). Dry matter intake and the digestibilities of dry matter, crude protein, cell-wall constituents, and gross energy all declined as the percentage of newspaper increased. In the second trial, each steer received 0.91 kg of concentrate per day. The level of paper was reduced to 3.75 and 7.5% by mixing the original two silages. Again the steers did not eat satisfactorily, and the digestibilities of the various constituents decreased as the percentage of paper increased. An in vitro study was conducted on direct-cut alfalfa silage containing 0, 5, 10, 15, or 20% newspaper, glossy magazine, or paper bags. The lignin content was highest for the silage containing the newspaper. The ash content was highest for the silages containing the glossy magazines. In vitro true digestibility was highest for silages containing paper bags. The addition of molasses to the silages containing paper decreased the pH of the silages with increasing levels of molasses from 0 to 7.5%. From these data it would appear that brown paper bags are more satisfactory than newsprint or glossy magazines to dilute alfalfa silage, thus decreasing its moisture percentage and reducing run-off losses. The results with molasses indicate that soluble carbohydrates may be a limiting factor when paper is added to direct-cut alfalfa.

SECTION X. ENVIRONMENTAL RESEARCH

Title: Effect of Slope Orientation on Climate and Crop Growth

Leader: M. A. Sprague (Rutgers University)

On the experimental pyramid, corn was grown no-till on the four slopes. Yield of grain was 15% greater on the north facing slope than on the south, with east and west being intermediate. Height was greatest on east and north slopes and lowest on west. Rainfall was greatest on the west slope and lowest on the east. Soil moisture remained highest on the north slope. Protein contents of orchardgrass and alfalfa were 3.1 and 2.5% higher, respectively, on the north slope than on the southern one. Floral maturity was earlier on the south slope.

Title: Handling and Utilizing Animal and Human Wastes in the Soil-Plant System (NE-110)

Leaders: H. D. Bartlett and L. E. Lanyon (The Pennsylvania State University)

Processed dairy manure (biogas generator effluent) was applied by subsurface injection methods to no-till corn at rates to supply approximately 120 and 240 lbs N per acre. The above treatments were made on one field each of an established bluegrass sod, corn stubble, and oat stubble. Manure applications were made in mid-April, approximately 10 days before planting. In the field with bluegrass sod, manure injection rows were laid out for planting directly in the injector row, between injector rows, and to one side of the injector row. The oat stubble and corn stubble fields had manure injected for application between each row of corn and at one side of the row, only. In addition to the manure, 200 lbs starter fertilizer (10-20-10) was applied with the planter to all plots.

Samples were taken from each field and treatment in September, before frost, for crop-yield determinations. The data are shown in Table 1. In general, higher yields resulted with the higher manure application rates. However, the results were not consistent, which may be attributed to difficulty in obtaining a representative sample due to irregularity of stand. Extremely dry conditions for a considerable period after planting resulted in great variability in seed germination and the resulting stand.

Also, residual effects of fall and spring liquid-manure-injection treatments to orchardgrass (1973-1975) were continued. Yield samples taken in May, July, and October 1977 showed continued residual response in direct relationship to manure-treatment rates. These data are presented in Table 2.

Table 1. Yields from dairy manure biogas generator effluent injection on no-till corn plots (1977).

Field	Placement in Row	Manure lbs N/A	Yield (lbs DM/A)		
			Grain	Stalks	Total
Bluegrass Sod	Under Row	235	8856	6887	15747
	Both Sides	235	9474	6260	15734
	One Side	117	7893	5219	13112
	Check*	0	12392	7092	19484
Oat Stubble	Both Sides	235	6384	3299	9683
	One Side	117	4001	3451	7541
	Check*	0	5178	2586	7764
Corn Stubble	Both Sides	235	7549	4979	12528
	One Side	117	6507	3039	11546
	Check*	0	5602	2905	8507

*Check = 200 lb 10-20-10 fertilizer as starter.

Table 2. Residual effect of liquid-manure injection on orchardgrass yields (1977). (Dairy manure injected fall 1973 and 1974 and spring 1974 and 1975).

Season	Manure (lbs N/A/yr)	1977 Yields (lbs DM/A)			Total
		1st Cut	2nd Cut	3rd Cut (10/77)	
Fall 1973 & 1974	300	1030	661.3	840.1	2531
	400	1150	685.7	944.6	2780
	500	1420	962.6	984.8	3367
Spring 1974 & 1975	300	1285	812.5	947.4	3045
	400	1475	838.3	1047.5	3361
	500	1520	943.4	1078.1	3542
	Check*	535	448.6	493.8	1477

*Check = 100 lb urea/A, Spring 1974 and 1975.

Title: Sudangrass Performance on Accumulated Surface Applied Sewage Sludge

Leaders: R. W. Duell and S. W. Cosky (Rutgers University)

Winterkilling of Midland bermudagrass (*Cynodon dactylon* L.) in 1975-1976 prompted establishment of Piper sudangrass (*Sorghum bicolor* (L.) Moench) in summer 1976 to measure residual effects of sewage sludge. Suspicion of inadequate availability of N and K from three rates of surface-applied residual sludge on three coastal plains soils suggested the application of additional fertilizer treatments. Sudangrass was drilled across tilled and untilled plots.

Tillage of plots that had received low rates of surface-applied sewage sludge resulted in establishment of more sudangrass plants, presumably because a better moisture regime existed there than in the untilled layer of dried sludge. Seedling heights were significantly greater in all tilled plots. Low yields of sudangrass the year after sludge applications ceased indicated low availability of nutrients from the residue of sludge applied in the previous 3 years. Supplementation with N, P, and K alone or in all combinations at 100 kg/ha of each element resulted in marked responses in plots that had large reserves of N and P in residual sludge. Yield responses to N alone were nil. Responses to K or NP were intermediate, but NK and NPK treatments were highest yielding.

Heavy metals, as well as nutrient elements, were measured in aerial tissue of the crop. Mineral concentrations of sudangrass were significantly altered by fertilizer treatments, tillage, and rate of sludge previously applied. In certain instances, interactions of factors appeared important.

Title: Effects of Sewage Sludge on Soils and Yield of Corn and Soybeans

Leaders: A. M. Decker and R. L. Chaney (University of Maryland)

Corn and soybeans were grown for the sixth season on the same plots that had received 0, 25, 50, and 100 dry tons/acre of digested sewage sludge in the spring of 1972. As in past years, 80 lb each of P₂O₅ and K₂O were applied to all fertilized plots; in addition, all fertilized corn plots received 160 lb N/A.

Corn-grain yields ranged from 13.5 bu/A with no sludge and no fertilizer to 121.7 bu with 100 tons of sludge plus fertilizer. The fertilized nonsludged plots produced 63.2 bu/A. Added fertilizer nitrogen increased grain at all sludge rates except the 50-ton rate. Silage yields followed a similar pattern with yields ranging from 9.99 to 18.12 tons/A.

Soybean yields were similar at the zero and 25-ton sludge rates; there was a significant increase at the 50 and again at the 100-ton rate. No increase in yield resulted from fertilizer application.

Title: Feasibility of Using Sewage Sludge for Plant and Animal Production

Leaders: A. M. Decker, J. P. Davidson, R. L. Chaney, S. B. Mohanty, and R. C. Hammond (University of Maryland)

Tall fescue pastures were treated with liquid and compost sewage sludges during the 1976 and 1977 grazing seasons. Liquid sludge was applied 3 weeks before grazing and 1 day before grazing. Compost sludge was applied three times during the 1977 grazing season; the rate was adjusted to supply the same amount of nitrogen that was applied with the liquid sludge. Check pastures were fertilized with NH_4NO_3 to supply the same amount of nitrogen. Ammonium nitrate was applied on the check pastures whenever liquid sludge was applied to the sludge pastures.

During the 1976 grazing season, a sludge high in iron was used, and cows with nursing calves on pastures sludged 1 day before grazing lost about half their body weight during the grazing season; steers maintained their weight during the first half of the grazing and then lost weight during the last half; nursing calves on the 1-day-sludge-treated pastures gained throughout the grazing season, but total weight gain was only about half that of the NH_4NO_3 -fertilized pastures. Iron and other metals accumulated in the livers and kidneys of all animals on sludge-treated pastures. The muscle accumulated very little metals.

An erosive chondro-arthritis developed in the elbow joints of all animals on the 1-day liquid sludge-treated pastures. This condition was also found with some of the 21-day sludge-treated pastures and with animals on the compost-sludge-treated pastures in 1977. This condition was not observed on any animals on the NH_4NO_3 -treated pastures in either year.

In 1977, a sludge lower in iron was used and animal performance was similar for the NH_4NO_3 , liquid sludge, and compost sludge-treated pastures. The erosive arthritic condition, however, was observed on all sludge-treated pastures.

LIST OF PUBLICATIONS

- Akao, S., N. J. Chatterton, G. E. Carlson, and W. E. Hungerford. 1977. Studies on the translocation of photosynthesis in alfalfa. *Bull. Shikoku Agric. Exp. Stn.* 30:129-234.
- Archer, K. A., and A. M. Decker. 1977. Autumn accumulated tall fescue and orchardgrass. I. Growth and quality as influenced by nitrogen and soil temperature. *Agron. J.* 69:601-605.
- Archer, K. A., and A. M. Decker. 1977. Autumn accumulated tall fescue and orchardgrass. II. Effects of leaf death on fiber components and quality parameters. *Agron. J.* 69:605-609.
- Archer, K. A., and A. M. Decker. 1977. Relationship between fibrous components and in vitro dry matter digestibility of autumn-saved grasses. *Agron. J.* 69:610-612.
- Baker, B. S., and R. L. Reid. 1977. Mineral concentration of forage species grown in central West Virginia on various soil series. *West Virginia Agric. Exp. Stn. Bull.* 657.
- Baker, P. B., and R. A. Byers. 1977. A laboratory technique for rearing the clover root curculio. *Melsheimer Entomol. Ser. No. 23* (December): 8-10.
- Baker, P. B., and R. H. Ratcliffe. 1977. Evaluation of bluegrass for tolerance to Blissus leucopterus hirtus (Hemiptera: Lygaeidae). *J. New York Entomol. Soc. (Abstr.)* p. 85.
- Balasko, J. A. 1977. Effects of N, P, and K fertilization on yield and quality of tall fescue forage in winter. *Agron. J.* 69:425-428.
- Barnes, D. K., E. L. Sorensen, R. N. Peadar, W. R. Kehr, J. H. Elgin, Jr., O. J. Hunt, T. E. Devine, I. I. Kawaguchi, F. I. Frosheiser, and C. H. Hanson. 1977. Registration of seventeen populations from the BIC alfalfa germplasm pool. *Crop Sci.* 17:675-676.
- Bennett, O. L., E. L. Mathias, and G. A. Jung. 1977. Responses of perennial grasses and legumes to slope and microclimate. *Int. Hill Land Symp. Proc.* In press.
- Berg, C. C., G. A. Jung, H. J. Donley, and R. E. Kocher. 1977. Perennial ryegrass as a forage in Pennsylvania. *NE Branch Am. Soc. Agron. Abstr.* p. 17.
- Bond, James, J. B. Powell, D. J. Undersander, L. I. Colbert, and R. R. Oltjen. 1978. Behavioral activity of steers grazing fescue. *ASAS South. Sect.* p. 33 (Abstr.).

- Bowersox, T. W., L. L. Wilson, and C. E. Fetzer. 1977. Winter sheltering of cows in a central Pennsylvania woodlot. *Anim. Sci. Res. Sum.* 5:155. Progress Report: Pennsylvania State University.
- Brown, C. A., P. T. Chandler, and J. B. Holter. 1977. Development of predictive equations for milk yield and dry matter intake in lactating cows. *J. Dairy Sci.* 60:1739-1754.
- Burton, G. W., W. W. Hanna, J. C. Johnson, Jr., D. B. Leuck, W. G. Monson, J. B. Powell, H. D. Wells, and N. W. Widstrom. 1977. Pleiotropic effects of the tr trichomeless gene in pearl millet on transpiration, forage quality, and pest resistance. *Crop Sci.* 17:613-616.
- Byers, R. A. 1977. The alfalfa blotch leafminer--introduced insect pest of alfalfa. *Pa. Grassland News* 17(1):3.
- Byers, R. A., D. L. Gustine, and B. G. Moyer. 1977. Toxicity of β -nitro-propionic acid to Trichoplusia ni. *Environ. Entomol.* 6:229-232.
- Byers, R. A., and G. A. Jung. 1977. Sweep-net survey of insect populations on forage grasses: effect of nitrogen fertilizer and insecticides. *Entomol. Soc. Am. Annu. Mtg.* p. 71.
- Byers, R. A., J. W. Neal, Jr., J. H. Elgin, Jr., K. R. Hill, J. R. McMurtrey, III, and J. Feldmesser. 1977. Systemic insecticides with spring-seeded alfalfa for control of potato leafhopper. *J. Econ. Entomol.* 70:337-340.
- Calvert, C. C. 1977. Systems for the indirect recycling by using animal and municipal wastes as a substrate for protein production. In New Feed Resources, FAO Anim. Production and Health Paper No. 4, P. 245-264.
- Calvert, C. C., and R. L. King. 1977. Dehydrated caged laying hen excreta (DPE) as a nitrogen supplement for lactating dairy cows. *Am. Dairy Sci. Assoc. Annu. Mtg. Proc.* 72nd (Abstr.) p. 141.
- Cathopoulos, T. E., L. L. Wilson, T. A. Long, W. L. Kjelgaard, P. M. Anderson, and H. Nehrir. 1977. Digestibility and intake of chemically treated silage. *Anim. Sci. Res. Sum.* 5:55. Pennsylvania State Univ.
- Chatterton, N. J., S. Akao, G. E. Carlson, and W. E. Hungerford. 1977. Physiological components of yield and tolerance to frequent harvests in alfalfa. *Crop Sci.* 17:918-923.
- Clancy, M., P. J. Wangsness, and B. R. Baumgardt. 1977. Effects of moisture determination method on estimates of digestibilities and intakes of conserved alfalfa. *J. Dairy Sci.* 60:216-223.
- Clancy, M., P. J. Wangsness, and B. R. Baumgardt. 1977. Effect of conservation method on digestibility, nitrogen balance, and prediction of energy intake of alfalfa. *J. Dairy Sci.* 60:572-579.
- Clancy, M., P. J. Wangsness, and B. R. Baumgardt. 1977. Effect of silage extract on voluntary intake, rumen fluid constituents, and rumen motility. *J. Dairy Sci.* 60:580-590.

- Colyer, Dale, F. L. Alt, J. A. Balasko, P. R. Henderlong, G. A. Jung, and Vinh Thang. 1977. Economic optima and price sensitivity of N fertilization for six perennial grasses. *Agron. J.* 69:514-517.
- Devine, T. E., R. H. Ratcliffe, T. H. Busbice, J. A. Schillinger, L. Hoffman, G. R. Buss, R. W. Cleveland, F. L. Lukezic, J. E. McMurtrey, and C. M. Rincker. 1977. Arc, a multiple pest-resistant alfalfa. U.S. Dept. Agric., ARS Tech. Bull. 1559. 28 pp.
- Downs, W. G., and W. L. McClellan. 1977. Sod-seeding legumes and grasses. *Forage Handbook for Pennsylvania*.
- Dum, S. A., R. S. Adams, J. E. Baylor, and A. R. Grout. 1977. Silage and Silos. Pennsylvania State Univ. College of Agric., Ext. Serv. Spec. Cir. 223. 30 pp.
- Elden, T. C., R. K. Howell, and R. E. Webb. 1978. Influence of ozone on pea aphid resistance in selected alfalfa strains. *J. Econ. Entomol.* 71:283-286.
- Elgin, J. H., Jr. 1977. Considerations in developing alfalfa for the Pacific Northwest. *Genetics Lectures* 5:131-135.
- Elgin, J. H., Jr., D. W. Evans, and L. R. Faulkner. 1977. Response of resistant and susceptible alfalfa cultivars to regional isolates of stem nematode. *Crop Sci.* 17:957-959.
- Elgin, J. H., Jr., and J. E. McMurtrey III. 1977. Effects of four greenhouse supplemental light sources on alfalfa flowering and seed production. *Can. J. Plant Sci.* 57:1213-1216.
- Elgin, J. H., Jr., J. E. McMurtrey III, and G. W. Schaeffer. 1977. Attempted interspecific hybridization of Medicago scutellata and M. sativa. *Agron. Abstr.* p. 54.
- Elgin, J. H., Jr., and R. H. Ratcliffe. 1977. Alfalfa weevil resistance in annual Medicago species. *Annu. Plant Resistance to Insects Newsl.* Vol. 3 (May 16) p. 25.
- Evans, J. L., and C. W. Kim. 1977. Diet ingestion and milk production as functions of diet Ca in Holstein cows. *J. Dairy Sci.* 60 (Suppl.): 115. Abstr.
- Evans, J. L., and C. W. Kim. 1977. Endogenous fecal Ca and true absorption as a function of Ca intake in Holstein cows. *J. Dairy Sci.* 60 (Suppl.):114. Abstr.
- Faust, R. M. 1977. Beltsville Agricultural Research Center Biohazards Safety Guide. 249 pp.

- Faust, R. M. 1977. Recombinant DNA research at the Agricultural Research Center. In Recombinant DNA Research Act of 1977, Hearings before the Subcommittee on Health and the Environment of the Committee on Interstate and Foreign Commerce, House of Representatives, 95th Congr. p. 307-311. Serial No. 95-18.
- Faust, R. M., and R. S. Travers. 1977. The Bacillus thuringiensis δ -endotoxin mode of action: current status. Soc. Invertebr. Pathol. Annu. Mtg. 10th (Michigan State Univ.). Paper presented.
- Fenner, H., and R. A. Damon, Jr. 1977. Effects of dietary magnesium levels on organic and inorganic constituents of cow's rumen fluid. J. Anim. Sci. 45:305 Suppl. 1.
- Fisher, D. D., L. L. Wilson, D. C. Kradel, J. B. Washko, P. C. Lootens, R. A. Peiffer, D. L. Lee. 1977. Hypomagnesemia in grazing beef cows and pasture productivity. Anim. Sci. Res. Sum. 5:147. Progress Report: Pennsylvania State University.
- Fisher, D. D., L. L. Wilson, P. C. Lootens, and R. W. Scholz. 1978. Grass and grass-legume pastures and the incidence of grass-tetany in beef cows. Sci. in Agric. 25(3):10.
- Goering, H. K. 1977. Direct-cut and wilted alfalfa ensiled with paragonaldehyde. Am. Dairy Sci. Assoc., Proc. p. 98-99.
- Goering, H. K. 1977. Growth and nitrogen retention of lambs fed alfalfa dehydrated at different temperatures. Int. Grassland Conf. Proc. 13th (Leipzig, German Democratic Republic) P. 352-358.
- Goering, H. K., and D. A. Dinius. 1977. Intake and growth of beef steers fed paraformaldehyde-treated hay-crop silages. NE Am. Soc. Anim. Sci.-Am. Dairy Sci. Assoc. Proc. p. 7.
- Goering, H. K., and L. W. Smith. 1977. Composition of the corn plant ensiled with excreta or nitrogen supplements and its effects on growing wethers. J. Anim. Sci. 44:452-461.
- Goering, H. K., T. R. Wrenn, L. F. Edmondson, J. R. Weyant, D. L. Wood, and J. Bitman. 1977. Feeding polyunsaturated vegetable oils to lactating cows. J. Dairy Sci. 60:739-747.
- Griffin, G. D., and J. H. Elgin, Jr. 1977. Penetration and development of Meloidogyne hapla in resistant and susceptible alfalfa under differing temperatures. J. Nematol. 9:51-56.
- Gross, C. F. 1977. Magnesium studies in Pennsylvania. (Submitted to The Tetany Times.)
- Gross, C. F., and G. A. Jung. 1978. Magnesium, Ca, and K concentration in temperate-origin forage species as affected by temperature and Mg fertilization. Agron. J. 70:397-403.

- Gustine, D. L., B. G. Moyer, P. J. Wangsness, and J. S. Shenk. 1977. Ruminant metabolism of 3-nitropropanoyl-D-glucopyranoses from crown-vetch. *J. Anim. Sci.* 44:1107-1111.
- Hartwig, N. L. 1977. Nutsedge control in no-tillage corn with and without a crownvetch cover crop. *Proc. NEWSS* 31:20-23.
- Hawes, D. T., and A. M. Decker. 1977. Healing potential of creeping bentgrass as affected by nitrogen and soil temperature. *Agron. J.* 69:212-214.
- Hill, R. R., Jr. 1977. Quantitative genetics of forages--potentials and pitfalls. *Agron. Abstr.* p. 58.
- Hill, R. R., Jr. 1977. Research in seeds for the future--forages. Forage, Corn, and Seed Conf. Pennsylvania State Univ. p. 21-22.
- Hill, R. R., Jr., and R. F. Barnes. 1977. Genetic variability for chemical composition of alfalfa. II. Yield and traits associated with digestibility. *Crop Sci.* 17:948-952.
- Holter, J. B., W. E. Urban, Jr., H. H. Hayes, and H. A. Davis. 1977. Utilization of diet components fed blended or separately to lactating cows. *J. Dairy Sci.* 60:1288-1293.
- Jung, G. A. 1977. Improving forage on marginal land--overview of problem and potential. *Soil Conserv. Soc. Am. Annu. Mtg. Proc. (Richmond, Va.) Abstr.*
- Jung, G. A. 1977. Mineral element composition of forages as related to animal requirements. *In* A. G. Matches and J. J. Marks (Ed.) *How far with forages for meat and milk production?* p. 93-103. Research-Industry Conf. Proc. 10th (Columbia, Mo.). Am. Forage and Grassland Council.
- Jung, G. A., G. A. Pearson, R. E. Fowler, D. M. Mitchell, and R. E. Kocher. 1977. Use of food-processing effluent for forage and beef production. *Agron. Abstr.* p. 117.
- Kendall, W. A., and J. S. Shenk. 1977. The utility of the meadow vole as a bioassay of forage quality. *Rumen Function Conf. Proc.* 14th (Nov. 30 to Dec. 1) Chicago, Ill. *Abstr.* p. 27.
- Keys, J. E., and L. W. Smith. 1977. Effect of corn stover silage diets supplemented with nitrogen from poultry excreta on dry matter intake and growth of yearling dairy heifers. *Am. Dairy Sci. Assoc. Annu. Mtg. Proc.* 72nd (Abstr.) p. 112.
- Kjelgaard, W. L. 1977. Energy and time needs in forage systems. *ASAE Paper No. 77-1512 (Chicago, Ill.) Dec.* 15 pp.
- Koch, D. W., and G. M. Dunn. 1977. Forage performance trials in New Hampshire. *New Hampshire Agric. Exp. Stn. Bull.* 505. 15 pp.

- Lea, H. Z., G. M. Dunn, and D. W. Koch. 1977. Stomatal diffusion resistance in three ploidy levels of smooth brome grass. *Crop Sci.* 17:91-93.
- Lea, H. Z., G. M. Dunn, and D. W. Koch. 1977. Stomatal indexes in three ploidy levels of Bromus inermis Leyss. *Crop Sci.* 17:669-670.
- Leath, K. T. 1977. Alfalfa crownwart. Forage legumes--diseases. *Coop. Plant Pest Rep.*, APHIS, U.S. Dept. Agric. 2:531.
- Leath, K. T., and R. A. Byers. 1978. Various pests of alfalfa "team up" to cause stress. *Sci. Agric.* 25(2):12.
- Linscott, D. L., and S. Durnin. 1977. A demonstration of no-tillage establishment of legumes on a mixed grass sod. *Minor-Cornell Programs. NE Branch Am. Soc. Agron. Abstr.* p. 10-11.
- Linscott, D. L., and S. Durnin. 1977. Powr-till planting vs. conventional planting of legumes in corn stubble. *Minor-Cornell Programs. NE Branch Am. Soc. Agron. Abstr.* p. 12.
- Linscott, D. L., and R. F. Lucey. 1977. Establishment of legumes by limited tillage methods. *NE Branch Am. Soc. Agron. Abstr.* p. 17.
- Linscott, D. L., R. F. Lucey, R. R. Seaney, and S. Durnin. 1977. Powr-till planting vs. conventional planting of legumes on a mixed grass sod. *Minor-Cornell Programs. NE Branch Am. Soc. Agron. Abstr.* p. 13.
- Lootens, P. C., D. L. Lee, L. L. Wilson, W. L. Kjelgaard, J. B. Washko, and T. A. Long. 1977. Comparison of hay package types. *NE ASAS and East. Canadian Anim. Sci. Mtgs. Fredericton, New Brunswick, Can.*
- Lootens, P. C., D. L. Lee, L. L. Wilson, W. L. Kjelgaard, J. B. Washko, and T. A. Long. 1977. Comparison of hay package types for beef cow wintering programs. *Anim. Sci. Res. Sum.* 5:153. *Pennsylvania State Univ.*
- Lynch, G. P., D. F. Smith, E. D. Jackson, R. C. Cope, and M. E. Simpson. 1977. Fungal degradation and nutritional value of cellulosic wastes. *J. Anim. Sci.* 44:883-888.
- Mainer, A., and K. T. Leath. 1977. Foliar disease: effect on protein and carbohydrate in leaves of alfalfa and orchardgrass. *Am. Phytopathol. Soc. Proc.* 4:148 (Abstr.).
- Maizlish, N. A., W. A. Kendall, and D. D. Fritton. 1977. Two computer-based techniques for root morphology studies. *Agron. Abstr.* p. 89.
- McNemar, J. H., C. C. Sheaffer, and N. A. Clark. 1977. Modification of a hay baler for applying organic preservatives to high moisture hay. *Agron. J.* 69:331-332.
- Moe, P. W., and H. F. Tyrrell. 1977. Effects of feed intake and physical form on energy value of corn in timothy hay diets for lactating cows. *J. Dairy Sci.* 60:752.

- Moe, P. W., and H. F. Tyrrell. 1977. The incremental energy value of wheat bran for dairy cows. NE ADSA-ASAS Proc. p. 6.
- Moe, P. W., and H. F. Tyrrell. 1977. Influence of endosperm type on energy value of corn grain for lactating cows. NE ADSA-ASAS Proc. p. 6.
- Moe, P. W., and H. F. Tyrrell. 1977. Influence of protein level on metabolizable energy value of diets for lactating cows. Am. Dairy Sci. Assoc. Mtg. Proc. 72nd p. 69.
- Mudgett, R. E., and R. Bajracharya. 1977. Enzymatic methods in plant protein recovery. Paper presented at NAR-ASAE Mtg. (Fredericton, New Brunswick, Can.) July 31 to Aug. 3.
- Mudgett, R. E., and K. Rajagopalan. 1978. Yeast cultivation on alfalfa process wastes. To be presented at Annu. Mtg. of NAR-ASAE (Amherst, Mass.) Aug. 6-9.
- Mudgett, R. E., R. Rufner, R. Bajracharya, K. Kim, and K. Rajagopalan. 1978. Enzyme effects on cell rupture in plant protein recovery. J. Food Biochem. In press.
- Murray, J. J. 1977. Differential response of turfgrass varieties to lime and aluminum. Virginia Turfgrass Conf. Proc. (Fredericksburg, Va.) Abstr.
- Murray, J. J., and C. D. Foy. 1978. Differential tolerance of turfgrass cultivars to an acid soil high in exchangeable aluminum. Agron. J. In press.
- Murray, J. J., and C. D. Foy. 1977. Lime responses of Kentucky bluegrass and tall fescue cultivars on an acid, aluminum-toxic soil. Int. Turfgrass Res. Conf. Proc. 3rd (Munich, Germany). In press.
- Muslih, Raad K., and D. L. Linscott. 1977. Regulation of lipid synthesis in soybeans by two benzoic acid herbicides. Plant Physiol. 60:730-735.
- NE-57 Technical Res. Committee. 1977. Northeastern regional evaluation of Kentucky bluegrass (Poa pratensis L.), 1968-1973. Bull. 814 Pennsylvania Agric. Exp. Stn. 58 pp.
- Nehrir, Hassan, W. L. Kjelgaard, P. M. Anderson, T. A. Long, L. D. Hoffman, J. B. Washko, and L. L. Wilson. 1977. Chemical additives for preservation of baled hay. Anim. Sci. Res. Sum. 5:137. Pennsylvania State Univ.
- Nehrir, Hassan, W. L. Kjelgaard, P. M. Anderson, T. A. Long, L. D. Hoffman, J. B. Washko, and L. L. Wilson. 1977. Effects of chemical additives on hay quality and dry matter preservation. Anim. Sci. Res. Sum. 5:133. Pennsylvania State Univ.

- Owens, L. D. 1977. Use of ^{15}N -enriched soil to study N_2 -fixation in grasses. In A. Hollaender et al. (Ed.) Genetic engineering for nitrogen fixation. p. 473. Plenum Publishing Corp., New York, N.Y.
- Powell, J. B. 1977. Breeding for improved turf and forage grasses. Grass Breeders Work Plann. Conf. Proc. 24th (Tifton, Ga.) p. 23 (Abstr.).
- Ratcliffe, R. H. 1977. Insect surveys in forage grasses. NE Reg. Alfalfa Insect Res. Conf. Proc. 14th (Burlington, Vt.).
- Reid, R. L., G. A. Jung, and C. F. Gross. 1977. Grass tetany as a metabolic problem in the Eastern United States. Int. Hill Land Symp. Proc. In press.
- Reid, R. L., G. A. Jung, and R. E. Kocher. 1977. Effects of magnesium fertilization on the nutritional quality of alfalfa. Agron. Abstr. p. 119.
- Reid, R. L., G. A. Jung, I. J. Roemig, and R. E. Kocher. 1978. Mineral utilization by lambs and guinea pigs fed Mg-fertilized grass and legume hays. Agron. J. 70:9-14.
- Schaaf, H. M., D. L. Linscott, R. Vaughan, and S. Durnin. 1977. Response of trefoil varieties to 2,4-D. Minor-Cornell Programs. NE Branch Am. Soc. Agron. Abstr. p. 10.
- Sheaffer, C. C. J. H. McNemar, and N. A. Clark. 1977. Potential of sunflowers for silage in double-cropping systems following small grains. Agron. J. 69:543-546.
- Shenk, J. S. 1977. Infrared grain and forage analyses promising. AFGC Forage and Grassland Progr. 18:1-2.
- Shenk, J. S. 1977. Near infrared--a rapid tool for forage and feedstuff analyses. Am. Forage Grassland Research-Industry Conf. Proc. 10th (Columbia, Mo.) p. 47-51.
- Shenk, J. S. 1977. The role of plant breeding in improving the nutritive value of forages. J. Dairy Sci. 60:300-305.
- Shenk, J. S., and R. F. Barnes. 1977. Current status of infrared reflectance. South. Pasture Forage Crops Impr. Conf. Proc. 34th (Auburn, Ala.) p. 57-61.
- Shenk, J. S., and M. R. Hoover. 1977. Infrared reflectance spectro-computer design and application. In Advances in automated analysis. Technicon Int. Congr. 1976. Vol. 2. Industrial Symposia (New York, N.Y.) p. 122-125.
- Shenk, J. S., W. N. Mason, M. L. Risius, K. H. Norris, and R. F. Barnes. 1977. Application of infrared reflectance analyses to feedstuff evaluation. Int. Symp. on Feed Composition, Animal Nutrient Requirements, and Computerization of Diets, 1st. (Logan, Utah) p. 242-248.

- Shenk, J. S., K. H. Norris, and R. F. Barnes. 1977. Forage and feedstuff analyses with infrared reflectance spectro-computer system. Int. Grassland Congr. Proc. 13th (Leipzig, German Democratic Republic) Sect. 10, p. 455-462.
- Simpson, M. E., and P. B. Marsh. 1977. Effect of added carbohydrates on in vitro cellulose digestion by bovine ruminal fluid. Am. Soc. Anim. Sci. Annu. Mtg. Proc. 69th (Abstr.) p. 257.
- Simpson, M. E., and P. B. Marsh. 1977. Vascular anatomy of cotton carpels as revealed by digestion in ruminal fluid. Crop Sci. 17:819-821.
- Simpson, M. E., P. B. Marsh, and G. V. Merola. 1977. Weight increase of cotton fibers during swelling in alkali as a sensitive measure of prior degradation in bovine ruminal fluid. Appl. Environ. Microbiol. 34: 302-307.
- Slyter, L. L., and D. L. Kern. 1977. Effect of sulfur on rumen microbe fermentation in vitro. NE Am. Soc. Anim. Sci.-Am. Dairy Sci. Assoc. Jt. Mtg. Proc. (Abstr.) p. 3.
- Slyter, L. L., D. L. Kern, and G. A. Varga. 1977. Rumen microbes in heifers fed hay, silage, or concentrates ad libitum. Am. Soc. Anim. Sci. Annu. Mtg. Proc. 69th (Abstr.).
- Slyter, L. L., and J. M. Weaver. 1977. Tetrahydrofoliate and other growth requirements of certain strains of Ruminococcus flavefaciens. Appl. Environ. Microbiol. 33:363-369.
- Smith, L. W. 1977. Corn stalks vs. wheat straw supplemented with poultry excreta or urea for lambs. Am. Soc. Anim. Sci. Annu. Mtg. Proc. 69th p. 8.
- Smith, L. W. 1977. The nutritional potential of recycled wastes. In New Feed Resources, FAO Anim. Production and Health Paper No. 4, p. 227-244.
- Smith, L. W., and I. L. Lindahl. 1977. Alfalfa vs. poultry excreta as nitrogen supplements for lambs. J. Anim. Sci. 44:152-157.
- Sprague, M. A., and B. B. Taylor. 1977. A technique of monitoring acidity of silage during preservation and storage. Agron. J. 69:727-728.
- Stout, W. L., D. P. Belesky, G. A. Jung, R. S. Adams, and B. L. Moser. 1977. A survey of Pennsylvania forage mineral levels with respect to dairy and beef cow nutrition. Pennsylvania Agric. Exp. Stn. Progr. Rep. 364. 16 pp.
- Sullivan, W. M., and G. M. Wood. 1977. Perennial ryegrass: A new forage for Vermont? NE Branch Am. Soc. Agron. Abstr. p. 17.
- Tan, G. Y., and G. M. Dunn. 1977. A polyhaploid clone of Bromus inermis Leyss with chromosome fragments. Cytologia 42:547-551.

- Tan, G. Y., and G. M. Dunn. 1977. Mitotic instabilities in tetraploid, hexaploid, and octoploid Bromus inermis. Can. J. Genet. Cytol. 19: 531-536.
- Terrell, E. E. 1977. A checklist of names for 3,000 vascular plants of economic importance. U.S. Dept. Agric. Handb. 505. 201 pp.
- Thompson, A. J., III, R. H. Hart, J. H. Elgin, Jr., and J. E. McMurtrey, III. 1977. Forage yield and quality of comfrey, alfalfa, orchardgrass, and brome grass. Agron. Abstr. p. 105.
- Traverse, R. S., R. M. Faust, and C. F. Reichelderfer. 1977. Catabolic efficiency of Bacillus popilliae under aerobic and anaerobic conditions. Soc. Invertebr. Pathol. Annu. Mtg. 10th (Abstr.) p. 8-9.
- Tyrrell, H. F., T. S. Rumsey, P. W. Moe, and D. A. Dinius. 1977. Energy metabolism of steers fed DES. ASAS Proc. p. 264.
- Tyrrell, H. F., D. R. Waldo, and P. W. Moe. 1977. Effect of paraformaldehyde treatment of forage and nitrogen supplementation of energy and nitrogen balance of dairy heifers fed orchardgrass silage. ASAS Proc. p. 264.
- Vance, C. P., and R. T. Sherwood. 1977. Lignified papilla formation as a mechanism for protection in reed canarygrass. Physiol. Plant Pathol. 10:247-256.
- Vandersall, J. H., L. W. Douglass, and C. A. Baile. 1977. Effect of elfazetam on feed intake, gain and efficiency of young dairy animals fed low quality forage and limited concentrate. NE ASAS-ADSA Mtg. Abstr. p. 24.
- Vaughan, R. H., and D. L. Linscott. 1977. Birdsfoot trefoil seed production research in the Champlain Valley. NE Branch Am. Soc. Agron. Abstr. p. 18.
- Waldo, D. R. 1977. Nutritional losses of harvested forage. Feed Manag. 27-30.
- Waldo, D. R. 1977. Potential of chemical preservation and improvement of forages. J. Dairy Sci. 60:306-326.
- Waldo, D. R. 1977. Protein degradation in ensiled feeds affects their value. Feed Manag. 11.
- Waldo, D. R. 1977. Some principles of forage intake and digestibility. Feed Manag.
- Waldo, D. R. 1977. Suggestions for improving silage. Research-Industry Conf. Proc. 10th, Am. Forage and Grassland Council. p. 69-91.
- Wangsness, P. J., L. F. Krabill, and C. A. Baile. 1977. Effect of Elfazepam on digestibility and feeding behavior in sheep. Fed. Proc. 36: 1141 (Abstr.).

- Washko, J. B., and L. L. Wilson. 1977. Progr. Rep. Carrying capacity of pastures utilized by crossbred Angus-Holstein cows and calves in 1976. *Anim. Sci. Res. Sum.* 5:151.
- Weaver, J. E., and T. S. Gallo. 1977. Studies on the parasites associated with the alfalfa weevil in West Virginia. *West Virginia Agric. Exp. Stn. Bull.* 652T. 14 pp.
- Welch, J. G., R. H. Palmer, and B. E. Gilman. 1977. Factors influencing rumen ingesta consistency and particle size. NE ADSA and ASAS with Can. Soc. Anim. Sci. (Fredricton, New Brunswick, Can.).
- Wells, G. D., and J. Beaudry. 1977. Comparing field losses from conventional square and big round balers. Paper presented at the Am. Soc. Agric. Eng. Winter Mtg. (Chicago, Ill.). ASAE Paper #77-1514.
- Wheeler, W. E. 1977. Buffers in dairy cattle feeds. *Cornell Nutr. Conf. Feed Mfg. Proc.* p. 53-58.
- Wheeler, W. E. 1977. Effect of limestone buffers on the digestion of complete mixed rations by dairy cows. *Am. Dairy Sci. Assoc. Proc.* p. 117.
- Wheeler, W. E., D. A. Dinius, and J. B. Coombe. 1977. Influence of potential digestibility and rate of digestion on utilization of low-quality forages in the rumen. *NE Am. Soc. Anim. Sci. Proc.* p. 4.
- Wheeler, W. E., and C. H. Noller. 1977. Gastrointestinal tract pH and starch in feces in ruminants. *J. Anim. Sci.* 44:131-135.
- Wheeler, W. E., and C. H. Noller. 1977. Starch utilization by dairy cattle fed complete mixed rations. *Maryland Nutr. Conf. Feed Mfg. Proc.* p. 63-70.
- Williams, H., J. S. Shenk, and D. E. Baker. 1977. Human kidneys and liver store cadmium of plants. *Sci. Agric.* 24(2):5.
- Wilson, L. L., and W. L. Kjelgaard. 1977. Large hay packages compared with bales. *Sci. Agric.* 24(4):2-3.
- Wood, G. M., and W. M. Sullivan. 1977. Short-term evaluations of turf-grasses for cold hardiness. *Int. Turfgrass Res. Conf. Proc.* 3rd (Munich, Germany). Submitted for publication.
- Woodson, F. E., B. S. Baker, J. B. Peters, M. R. Fausett, and E. K. Inskeep. 1977. A Progress Rep. on The Allegheny Highlands Project: Agriculture. Jan.-Dec. 1976. *West Virginia Univ. College of Agric. and Forestry.*
- Sperow, C. B., Jr., B. S. Baker, and S. P. Washburn. 1977. Energy relationships on selected dairy and beef farms in West Virginia. *NE Branch Am. Soc. Agron. Abstr.* p. 17.

- Wilson, L. L., Hassan Nehrir, W. L. Kjelgaard, P. M. Anderson, L. D. Hoffman, and J. B. Washko. 1977. Chemical additives for hay. NE ASAS and East. Canadian Anim. Sci. Mtgs. (Fredricton, New Brunswick, Can.).
- Wilson, L. L., and W. L. Kjelgaard. 1977. Large hay packages compared with bales. Sci. Agric. 24(4):2-3.
- Wilson, L. L., W. L. Kjelgaard, J. B. Washko, P. C. Lootens, D. L. Lee, and T. A. Long. 1977. Harvesting and feeding large hay packages. Anim. Sci. Res. Sum. 5:91. Pennsylvania State Univ.
- Young, K. R., and J. B. Holter. 1977. Effect of a commercial additive in wilted grass silage preservation and nutritive value in dairy heifers. NED-ADSA (Fredricton, New Brunswick, Can.) Abstr.
- Young, K. R., and J. B. Holter. 1978. Influence of a commercial preservative applied to hay baled (rectangular bales) at different levels of moisture on nutritive value in dairy heifers. NED-ADSA (Amherst, Mass.) Abstr.
- Zeiders, K. E., and R. T. Sherwood. 1977. Effect of irrigation with sewage wastewater, cutting management, and genotype on tawny blotch of reed canarygrass. Crop Sci. 17:594-596.
- Zeiders, K. E., and R. T. Sherwood. 1977. Reaction of reed canarygrass genotypes to the leafspot pathogens Stagonospora foliicola and Helminthosporium catenarium. Crop Sci. 17:651-653.

RECIPIENTS OF GRADUATE DEGREES

--M.S. DEGREES--

Name - Institution - Advisor	Thesis Title
M. BARRETT University of Connecticut (R. A. Peters)	Water relationships of corn, lambs- quarters, and fall panicum as a factor in crop weed competition
R. N. NICHOLS University of Connecticut (D. W. Allinson)	The fertilization of sudangrass culti- vars with poultry manure
HISHAMUDDIN BINJAMALUDIN University of Massachusetts (L. F. Whitney)	Alfalfa protein decolorization by filtration
K. R. YOUNG University of New Hampshire (J. B. Holter)	Effect of a commercial additive in wilted grass silage on silage preservation and nutritive value in dairy heifers
THEMELIS E. CATHOPOULIS The Pennsylvania State University (L. L. Wilson)	Effects of acid-treatment silage on preservation qualities and digesti- bility of hay and silage
DALE D. FISHER The Pennsylvania State University (L. L. Wilson)	Factors contributing to the occurrence of hypomagnesemia in lactating Angus and Angus-Charolais cows on pasture
K. C. RINEER The Pennsylvania State University (M. L. Risius)	Variation for Beta-nitropropionic acid in crownvetch (<u>Coronilla varia</u> L.)
JOSEPH P. ZUBLENA Rutgers University (M. A. Sprague)	The effect of field curing time on the hydrolyzable carbohydrate and protein contents of alfalfa forage (<u>Medicago</u> <u>sativa</u> L.) while lying in the swath
W. MICHAEL SULLIVAN University of Vermont (G. M. Wood)	An evaluation of the agronomic value and relative hardiness of perennial ryegrass, <u>Lolium perenne</u> L.
L. C. STUART West Virginia University (L. Butler)	Field evaluations of insect growth regulators on alfalfa insect pests
Y. J. CHEN West Virginia University (L. Butler)	Analysis of the effect of Regulaid on malathion-treated houseflies

<u>Name - Institution - Advisor</u>	<u>Thesis Title</u>
J. N. MC KINLEY Rutgers University	Calcium nutrition and requirement in prepartum dairy cows as influenced by diet calcium and age, with emphasis on hydroxyproline as indicator
R. M. BASCH Rutgers University	Influence of age and diet calcium on calcium, magnesium, phosphorus, and dry matter metabolism in prepartum Holstein cows
TIMOTHY L. HORN University of Maryland (J. H. Vandersall)	The nutritive value of direct-cut alfalfa ensiled with various types and levels of paper

--Ph.D. DEGREES--

<u>Name - Institution - Advisor</u>	<u>Thesis Title</u>
H. Z. LEA University of New Hampshire (G. M. Dunn)	Genetics of a rolled-leaf mutant in smooth brome grass, <u>Bromus inermis</u> Leyss
RONALD F. GUYTON The Pennsylvania State University (J. B. Washko)	Irrigation, harvest interval, and nitrogen effects on forage production and quality of green panicgrass (<u>Panicum</u> <u>maximum</u> var. <u>Trichoglume</u> Elyes) alone and with tropical legumes
DONG HO BAE University of Vermont (J. G. Welch)	Study on efficiency of mastication and rumination in relation to amount of hay intake and body size in cattle
MARVA S. BROWNE West Virginia University (R. L. Reid)	An evaluation of tropical perennial forages for goat production in the Virgin Islands
CRAIG C. SHEAFFER University of Maryland (A. M. Decker)	Soil temperature and sewage sludge application effects: I. Crop growth and heavy metal concentrations. II. Soil organic matter decomposition and extractable metals

